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ABSTRACT

This teacher's guide was developed to aid in presenting units on general metal trades to students in Texas. The units are intended to provide students with basic knowledge and skills for each area of instruction in the general metal trades, and with the basic entry-level skills they will need in order to enter industry as trained workers. This guide contains five units covering the following subjects: hand tools, fasteners, sheet metal basics, sheet metal fabrication, and ornamental ironwork. Each unit includes most or all of these basic components of a unit of instruction: performance objectives, suggested teaching activities, information sheets, transparency masters, assignment sheets, job sheets, unit tests, and answers to unit tests. Directions to the teacher on how to use the materials, as well as references for further information, are included. (KC)

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Units of Instruction

GENERAL METAL TRADES

Book III

Teacher's Guide

Prepared by
Durwin Hohhertz

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GENERAL METAL TRADES--BOOK III

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PREFACE

GENERAL METAL TRADES--BOOK III was prepared with the assistance of numerous instructors across the state in an attempt to provide adequate instructional materials for the General Metal Trades programs in Texas. Since it is known that instructional content varies from program to program, these units were developed to provide students with a basic coverage of knowledges and skills for each area of instruction in the general metal trades.

If properly presented, these materials will provide a stimulus for student interest in pursuing training in one or more areas of instruction related to the occupational areas within the General Metal Trades Cluster. Also, the information and skill training provided through the use of this guide will equip the students with the basic entry-level skills they will need to have in order to enter industry as trained workers.

This guide, along with GENERAL METAL TRADES--BOOK I, GENERAL METAL TRADES--BOOK II, and GENERAL METAL TRADES--WELDING, all produced by the Occupational Curriculum Laboratory, should serve as an excellent basis for the General Metal Trades course of study.

Bill Barnes, Ph.D.
Director
Occupational Curriculum Laboratory

ACKNOWLEDGMENTS

Appreciation is extended to the many individuals who contributed their time and talents to the development of these materials for the General Metal Trades programs.

Durwin Hohhertz, former Curriculum Writer and Director of the Occuptional Curriculum Laboratory, was the principal author of this publication and thus deserves the credit for the scope and quality.

The contents of the publication were planned and reviewed by the following General Metal Trades instructors:

Richard Perez, El Paso

Ed Fahsholtz, Lubbock

Ronnie Stanley, Longview

Phillip Reed, Dallas

Ray Blohm, Dallas

A special thanks goes to Ron McBride of West Texas State University, Canyon, Texas, who assisted with the research and technical content.

Gratitude is expressed to Frances Hyatt and the clerical staff for typesetting and editing, and to Bob Norsworthy and the graphic arts staff for the many illustrations and transparency masters they provided.

John Leugemors and the Print Shop staff deserve much credit for the quality of the printing of the publication.

USE OF THE INSTRUCTIONAL UNITS

These units cover certain instructional areas in the General Metal Trades program. Each unit includes most or all of the basic components of a unit of instruction: performance objectives, suggested teaching activities, information sheets, transparency masters, assignment sheets, job sheets, unit tests and answers to unit tests. Units are planned for more than one classroom period of instruction.

Careful study of each instructional unit will enable the teacher to determine:

A. The amount of material that can be covered in each class period

B. The skills that must be demonstrated

C. Supplies and equipment needed for skill performance

D. The amount of classroom time needed for teacher demonstration and student practice

E. Supplementary materials that must be ordered

F. Any resource personnel who must be contacted

The specific components of an instructional unit perform the following functions:

OBJECTIVES

Each unit of instruction is based on performance objectives. These objectives specify the exact behaviors the student will be exhibiting, thus providing students with a sense of direction.

Performance objectives are stated in two forms. The unit objectives state the materials to be covered in the unit of instruction and how the student will handle the material. Specific objectives state the types of performance the student will be doing to satisfy the unit objective.

A classroom discussion should follow immediately after the students read the objectives so that any questions concerning the performances expected of the student can be answered.

SUGGESTED TEACHING ACTIVITIES

Each unit of instruction has a suggested teaching activities sheet outlining steps to follow in accomplishing specific objectives.

Duties of the instructor will vary from unit to unit, but the following are minimum activities for the instructor:

1. Provide students with objectives, information, assignment, and/or job sheets

2. Discuss objectives and information sheets

3. Make transparencies

4. Demonstrate procedures outlined on job sheets (when included)

5. Give test

Many additional instructional activities and teaching methods are included to assist the instructor with classroom instruction and student motivation.

INFORMATION SHEETS

Information sheets provide content essential for meeting the cognitive requirements of the unit. These sheets provide an excellent guide for presenting required explantions necessary to develop the skills specified in the the unit objective.

Students should read the information sheets before the information is discussed in class. Students are encouraged to make any additional notes on the information sheets to help them in their learning process.

TRANSPARENCY MASTERS

Transparency masters provide information in a special way. Transparencies may present new information or they may reinforce information presented in the information sheets. These are particularly effective when identification is necessary.

Make the transparencies from the masters and place them in your notebook ready for immediate use.

JOB SHEETS

Job sheets are an integral part of each unit of instruction. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures specified in the job sheets give direction to the skill being taught, and allow both the student and the teacher to check student progress in performing the skill. Job sheets provide a ready outline to students and furnish to potential employers a picture of the types of skills being taught.

ASSIGNMENT SHEETS

Assignment sheets give direction to study and furnish activities which provide application of the material contained in the information sheet. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided for checking student progress.

ANSWERS TO ASSIGNMENTS

Assignment answers are provided for the instructor's convenience in each unit. These may be used by the teacher and/or student. Some assignments do not require specific answers, but depend upon student participation. These should be graded on an individual basis according to participation.

UNIT EVALUATION

Questions in the Unit Evaluation have been constructed to measure student achievement of each specific objective listed on the objective sheet. Individual test items may be pulled out to be used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz (oral or written) and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective.

ANSWERS TO EVALUATIONS

Answers are provided for each unit evaluation. These may be used by the teacher and/or student for checking student achievement of the objectives. The instructor should reinforce the correct answers when a question is missed.

PERSONALIZING AND LOCALIZING INSTRUCTIONAL UNITS

Carefully review the instructional units before using them in the classroom. In reviewing the units, you will find it necessary to localize and personalize the material based upon the needs of your students. You will also find it necessary to organize the materials in the proper teaching sequence to follow your course outline and lesson plans.

Some of the ways of supplementing units include the use of audio-visuals, attention-getters, field trips, resource personnel, games and simulations, case studies, peer teaching, role-playing, and personal experiences of both the teacher and students.

Various methods may be used in localizing a unit of instruction. You may wish to apply units of instruction to the local community, add additional materials from newspapers and magazines, invite local resource people, and arrange for field trips.

In personalizing a unit of instruction, you may want to make the course content relevant to home and/or work situations. You may wish to involve students in the planning of the unit by using their own personal experiences. Having students involved in the teaching of some of the materials is sometimes an effective example of peer teaching.

Remember that as an instructor, you may with to add any objectives to the units of instruction based on the individual needs of the student. If this procedure is followed, you must add the corresponding information in the information sheet, add any assignment or job sheets as deemed necessary, and construct a corresponding unit test item.

Section A

BENCHWORK

UNIT I

HAND TOOLS

UNIT OBJECTIVE

After completing this unit, the student will be able to identify the types of handtools used in the shop and select the correct safety rules to follow when using them for different jobs. This knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Match the terms associated with handtools to the correct definition.
2. Identify the types of pliers.
3. Identify the types of screwdrivers.
4. Identify the types of wrenches.
5. Identify the types of files according to their use.
6. Identify the types of threading tools.
7. Identify the types of squares.
8. Identify the types of clamping devices.
9. Identify other types of handtools.
10. Point out the basic causes of handtool accidents.
11. Select the rules to follow when using handtools.
12. Demonstrate the ability to:
    a. Replace a ball peen hammer handle.
    b. Reshape a common screwdriver.
    c. Reshape a mushroomed chisel or punch.
    d. Sharpen a cold chisel.
    e. Drill and tap a blind hole.
    f. Thread a shaft.

UNIT I

HAND TOOLS

SUGGESTED TEACHING ACTIVITIES

I. Objective sheet

   A. Discuss the unit objective with students.

   B. Discuss each specific objective with the students.

   C. Have the students complete the objectives in the most logical sequence for shop organization.

   D. Add any objectives necessary

II. Information sheets

   A. INFORMATION SHEET 1--TYPES OF HAND TOOLS

      1. Display the various hand tools used in the shop. (Transparencies 1-7)

      2. Explain the use of each tool.

      3. Discuss the storage and check out system for tools in the shop.

   B. INFORMATION SHEET 2--HAND TOOLS

      1. Explain safety factors involved with use of hand tools. (Transparency 8)

      2. Explain the proper care of hand tools.

      3. Explain what to do with damaged tools.

III. Transparency masters

   (NOTE: Transparency masters are included in student manuals as information sheets.)

   A. TM-1--TYPES OF PLIERS
   B. TM-2--TYPES OF SCREWDRIVERS
   C. TM-3--TYPES OF WRENCHES
   D. TM-4--TYPES OF HAMMERS
   E. TM-5--PUNCHES AND CHISELS
   F. TM-6--TYPES OF FILES
   G. TM-7--CLAMPING DEVICES
   H. TM-8--CAUSES OF HAND TOOL INJURIES
   I. TM-9--TAP DRILL SIZES

IV. Job sheets

A. JOB SHEET 1--REPLACE A BALL PEEN HAMMER HANDLE

1. Demonstrate the replacement of a handle.
2. Explain the importance of a well fitted handle.
3. Allow different students to replace handles as they are broken.

B. JOB SHEET 2--RESHAPE A COMMON SCREWDRIVER

1. Explain the need to shape a screwdriver tip.
2. Demonstrate the procedure.
3. Discuss the safety precautions for using the grinder.
4. Explain what overheating when grinding does to the hardened metal.

C. JOB SHEET 3--RESHAPE A MUSHROOMED CHISEL OR PUNCH

1. Explain the danger of mushroom headed chisels or punches.
2. Demonstrate the procedure.
3. Caution students on the use of the grinder.

D. JOB SHEET 4--SHARPEN A COLD CHISEL

1. Explain the safety factors for keeping chisels sharpened.
2. Demonstrate the procedure.
3. Explain the need for grinding various angles.

E. JOB SHEET 5--DRILL AND TAP A BLIND HOLE

1. Discuss tap drill sizes (Transparency 9)
2. Demonstrate the procedure
3. Caution the students on the correct method of holding the tap wrench.

F. JOB SHEET 6--THREAD A SHAFT

1. Show students how to chamfer round stock on the grinder.
2. Demonstrate the adjustment of a split die.
3. Explain the purposes of cutting oil.

V. Unit test

A. The unit test is divided into two parts.

(NOTE: Each part covers one information sheet.)

B. Various approaches may be used in testing:

1. Give each part of the test after the student has completed studying the information on one information sheet.

2. Give the entire test upon the completion of all the information sheets in a unit.

3. Give one or more parts of the test as an assignment or to reinforce problem areas of learning.

C. Include test parts corresponding to any information area or sheets added to the unit.

VI. Answers to test

A. Answers are based on total information covered in the unit.

B. For convenience of grading, make corresponding answer sheets for additional test parts included.

VII. References

A. Walker, John. Modern Metalworking. Goodheart. Wilcox, 123 W. Taft Drive, South Holland, Illinois 60473

B. Lascoe, Nelson, and Porter. Machineshop Operations and Setups. American Technical Society, Chicago, Illinois, 4th ed., 1973.

C. McCarthy and Smith, Machine Tool Technology. McKnight and McKnight. Bloomington, Illinois, 3rd ed., 1968.

D. A Suggested Basic Course Outline for General Metal Trades Cluster. Occupational Curriculum Laboratory, East Texas State University, Commerce, Texas 75428.

UNIT I

HAND TOOLS

INFORMATION SHEET 1--TYPES OF HANDTOOLS

I. Terms and definitions

A. Double-cut--A surface on a file that has two cutting angles which cross.

B. Single-cut--A surface on a file that has only one cutting angle.

C. Thread-fit--The tightness of a threaded bolt in a hole.

(NOTE: Classes of fits are 1-loose, 2-free, 3-medium, and 4-close.)

D. Machine screw--Screws smaller than ¼" in diameter.

E. Number of threads per inch--The count of threads in one inch distance.

II. Types of pliers

A. Slip joint--All-purpose pliers

B. Vise grip--Pliers with a locking action used to hold material tightly.

C. Needle nose--Pointed pliers used for working in tight areas or holding small parts.

D. Channellock--Adjustable pliers used for holding objects of various sizes.

E. Side cutters--Used to cut wire or small metal parts.

F. Diagonals--Used for cutting wire.

G. Thread series--Refers to the number of threads per inch on a specific size of a bolt.

(NOTE: The two most common series of threads are Unified National Fine [UNF] and Unified National Coarse [UNC].)

III. Types of screwdrivers

A. Common (Standard)--General purpose flat-tipped screwdriver.

B. Phillips--Used with phillips-headed screws

C. Offset--Used on screws in hard-to-get to places.

IV. Types of wrenches

A. Adjustable--General purpose wrench.

B. Box end--Enclosed-end wrenches of various sizes.

C. Open end--Wrenches with open ends which are various sizes.

D. Combination--Wrenches with one open end and a closed end of equal size.

E. Allen--Wrenches which fit into a hexagon-shaped recess or hole in a screw.

F. Socket--Used with ratchet or breakover handles to tighten or loosen recessed bolt heads.

(NOTE: Breakover handles are used to loosen nuts or bolts and then the ratchet is used for quick removal or tightening.)

G. Pipe wrench--Used to tighten or loosen pipe fittings.

V. Types of hammers

A. Ball peen--Used as a general purpose shop hammer

(NOTE: These vary in weight from 2, 4, 8, or 12 ounces to 1, 1¼, 1½, 2, or 3 pounds.)

B. Mallet--Used to strike surfaces that would be damaged by ball peen hammers.

1. Rawhide

2. Plastic

C. Sledge--Used when more striking force is required.

(NOTE: Sledge hammers vary in size from 2½, 3, 4, 6, 8, 10, and 12 pounds.)

D. Blacksmith--A small sledge-like hammer used in forging and metal shaping.

VI. Types of punches and chisels

A. Punches

1. Center--Used to provide a starting point for drilling.

2. Drift--Used to align bolt holes or punch pins or bolts from holes.

3. Prick--Used to accurately mark layout points on metal for machining.

4. Solid--Used to remove larger bolts and shafts from holes.

5. Pin--Used to remove small split or taper pins from machine parts.

B. Chisels

1. Flat cold--Used to cut off bolt or rivet heads.

2. Diamond point--Used to cut a V-groove or sharp corners on inside corners.

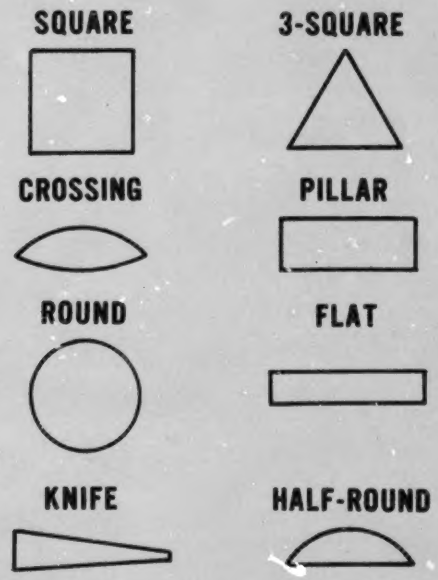
3. Round nose--Used to cut rounded grooves.

4. Cape--Used to cut slots, corners, or keyways.

VII. Files

A. Shapes

1. Square
2. 3-Square
3. Crossing
4. Pillar
5. Round
6. Flat
7. Knife
8. Half-round



B. Types

1. Machinist--A double-cut file used to remove metal quickly.

2. Mill--A single-cut file used for general filing when a smooth finish is required.

3. Lathe--A long angle single-cut file used for filing on the lathe.

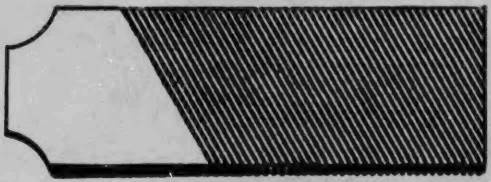
4. Rasp--A coarse-cut file used for soft metals and plastics.

5. Jewelers--Various-shaped files which are used by jewelers and tool and die makers.

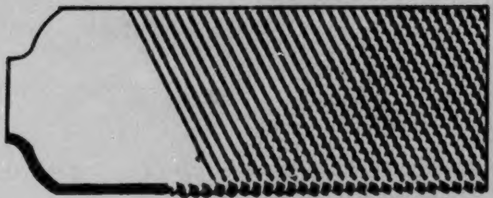
C. Classification of files

1. Cut of teeth

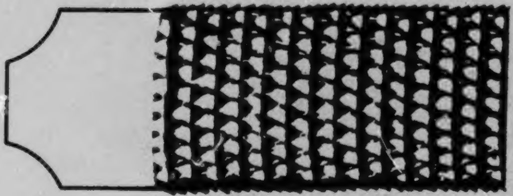
a. Single-cut



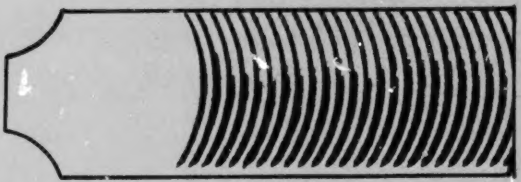
b. Double-cut



c. Rasp

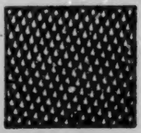


d. Curved-toothed

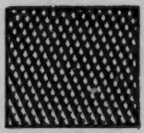


2. Coarseness of teeth

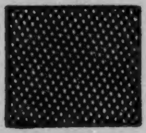
a. Rough



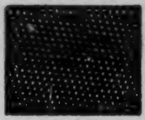
b. Coarse



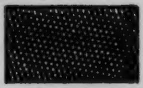
c. Bastard



d. Second-cut



e. Smooth



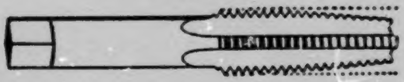
f. Dead smooth

VIII. Types of threading tools

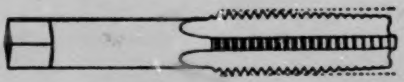
A. Taps--Used to thread holes

(NOTE: Taps are found in common fractional sizes from ¼ inch up to 1 inch in both National coarse and National fine series.)

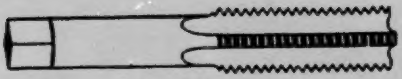
1. Taper--Used to start the threading



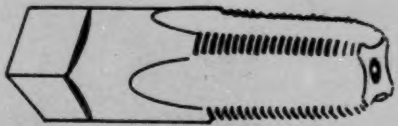
2. Plug--Used to cut threads nearly to the bottom of a hole



3. Bottoming--Used to finish threading to the bottom of a hole



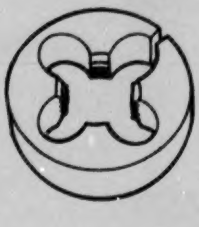
4. Pipe tap--A tapered tap used to provide threads of various pipe sizes.



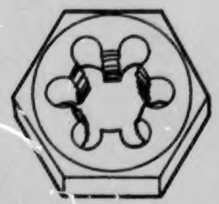
B. Dies--Used to thread round stock

(NOTE: Dies are found in common fractional sizes from ¼ inch up to 1 inch in both National Coarse and National Fine series.)

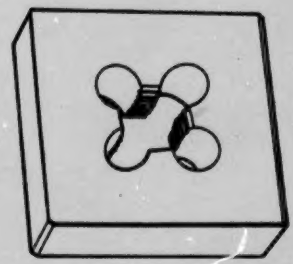
1. Split--Can be adjusted slightly for different thread fits.



2. Solid--Has no adjustment.



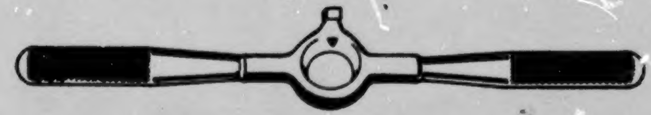
HEXAGON



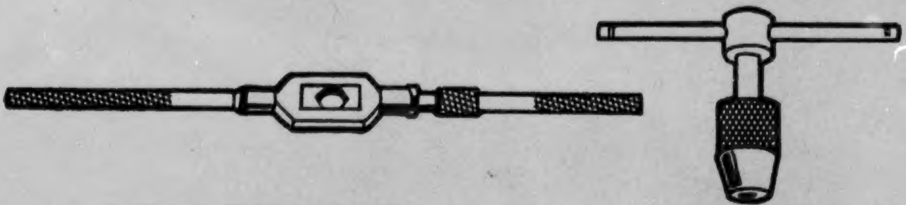
SQUARE

C. Accessories

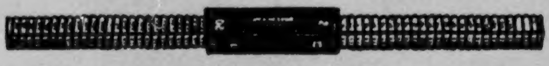
1. Diestock--Used to hold dies when threading



2. Tap wrench--Used to hold taps when threading

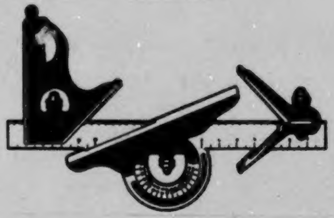


3. Thread restorer--Used to repair damaged threads



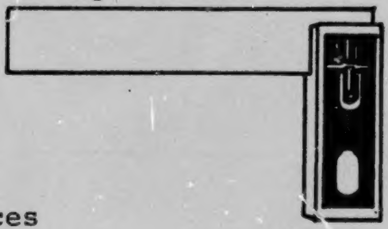
IX. Squares--Used in layout, checking, and set-up of workpieces and equipment.

A. Combination--Consists of a square head, center head, and bevel protractor on a blade.



B. Steel--Used to layout large areas or check large parts.

C. Try--Used to layout small areas or check small parts.



X. Clamping devices

A. Machinist vise or bench vise--General purpose vise.

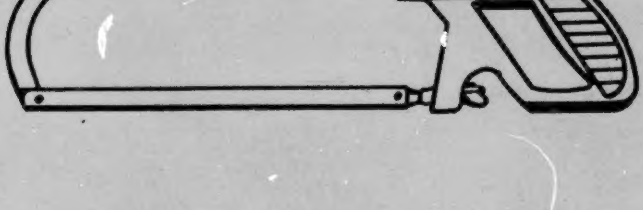
B. Toolmakers vise--A vise used in toolmaking which may be swiveled in many directions.

C. Parallel clamp--Used to clamp small parts for layout.

D. C-clamp--Used in set-up of machines and workpieces.

XI. Other handtools

A. Hacksaw--Used to cut stock to length or in rough cutting a workpiece to shape.



B. Emery cloth--Used in polishing a workpiece to a specified finish.

1. Comes in 9" x 11" sheets or rolls ½" to 3" wide.

2. Available in many grain sizes.

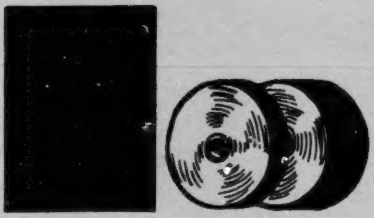
(NOTE: The following are grain sizes commonly used for hand polishing:)

a. No. 60--medium coarse

b. No. 80--medium

c. No. 120--medium fine

d. No. 180--fine



UNIT I

HANDTOOLS

INFORMATION SHEET 2--HANDTOOL SAFETY

I. Basic causes of handtool accidents

A. Using defective tools.

1. Tools should be inspected on a daily basis.

2. Tools should be repaired or taken out of use if found to be defective.

B. Using the wrong tool for a job.

1. Tools are made for a specific use, and can be dangerous if used for a job different from the one for which they were designed.

2. Be sure to find out what each tool is designed to do.

C. Using a tool incorrectly.

1. Even though a tool is being used on the right job, the tool can be dangerous if use incorrectly.

2. Be sure to use a tool in the correct way each time it is used for a job.

D. Improperly storing and caring for tools.

1. Each tool should be placed in its proper storage place and kept clean.

2. Tools should be put in a safe place while they are being used around any equipment so they will not fall off or be thrown into moving parts.

II. Rules for the use of handtools

A. Select the proper size and type of tool that is required for each job.

A Correct Screwdriver Fit

A Poor Fit Damages the Screwdriver and Screw Slot

B. Learn how to use tools properly.

C. Make sure tools are always in good condition and cutting tools are properly sharpened.

D. Keep tools clean and dry.

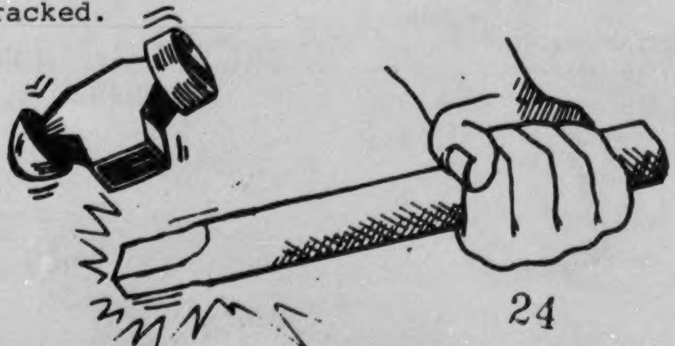
E. Handle sharp-edged or pointed tools with care. Keep the points or sharp edges away from yourself and others when carrying or in use.

F. Keep sharp-edged or pointed tools away from the edge of the table or workbench.

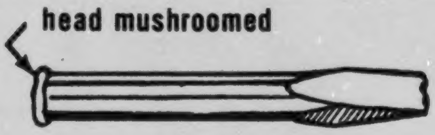
G. Never carry tools in your pockets or carry more than you can handle.

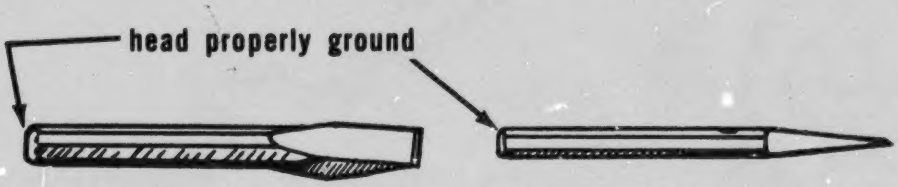
H. Do not use tools for jobs other than which they were intended.

I. Keep handles on tools and make sure handles are secure and not cracked.



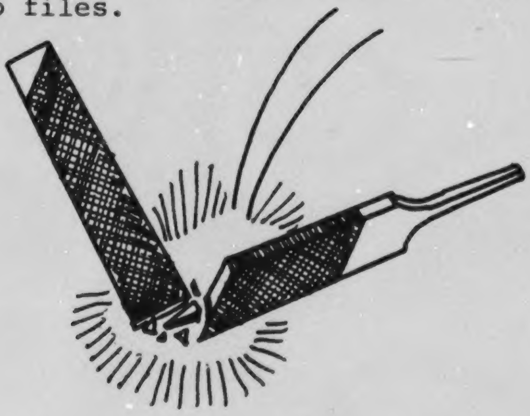
J. Keep mushroomed heads ground off punches and chisels





K. Saw lightly when you are nearing completion of a cut with a hacksaw.

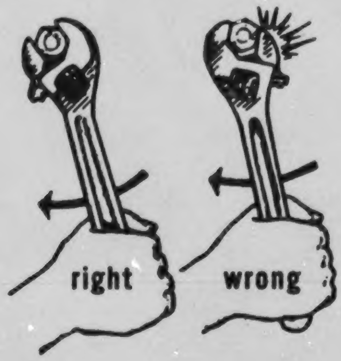
L. Use files only when equipped with a handle and never pry or drop files.



M. Do not use screwdrivers for pry bars or chisels.

N. Do not strike on hardened tools with a hard-faced hammer.

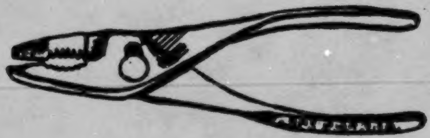
O. Select wrenches that fit properly, and always pull rather than push on them.



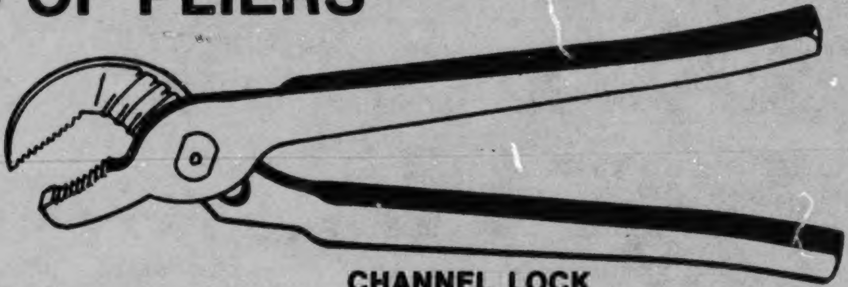
P. Tell your instructor about any faulty or broken tools.

Q. Return tools to their proper storage after use.

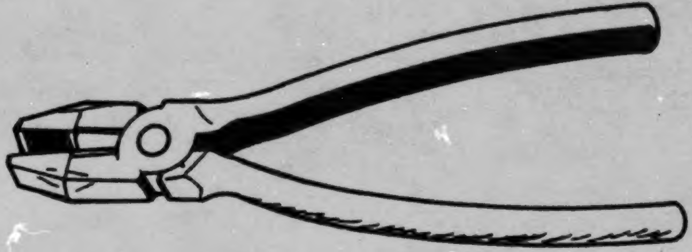
TYPES OF PLIERS



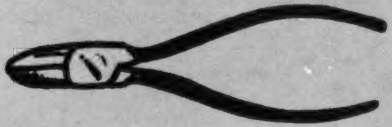
SLIP JOINT



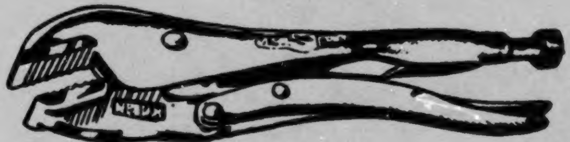
CHANNEL LOCK



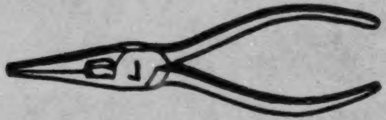
SIDE CUTTERS



DIAGONALS



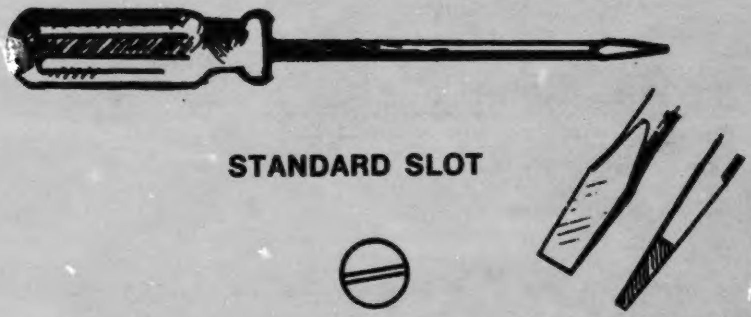
VISE GRIPS



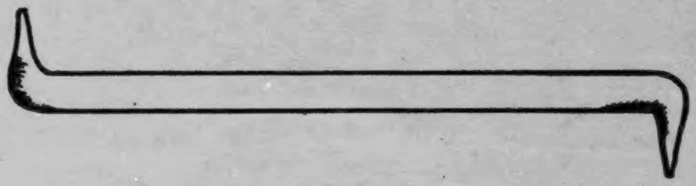
NEEDLE NOSE

TM-1

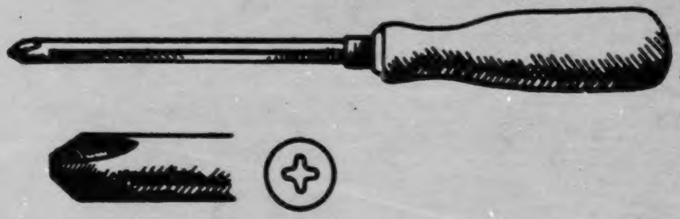
TYPES OF SCREWDRIVERS



STANDARD SLOT

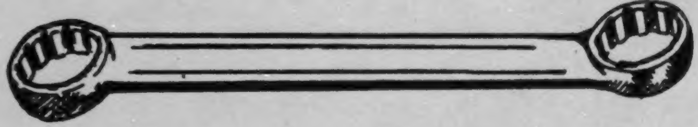


OFFSET

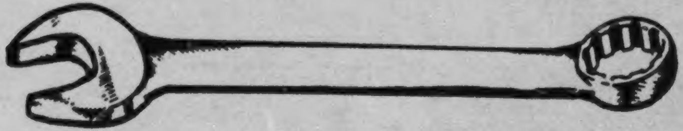


PHILLIPS

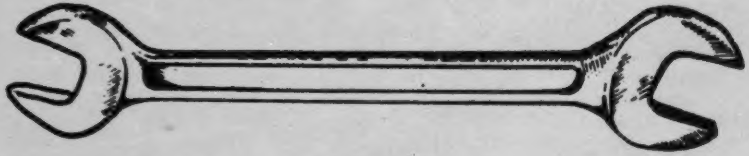
TYPES OF WRENCHES



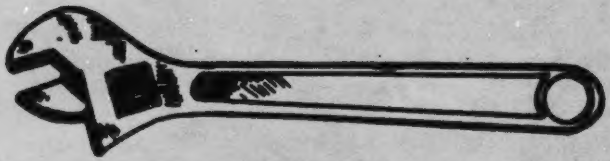
BOX END



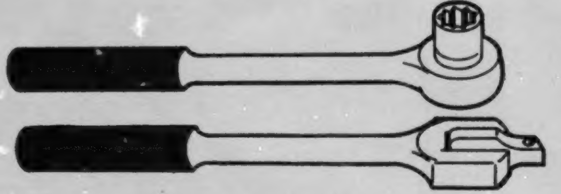
COMBINATION



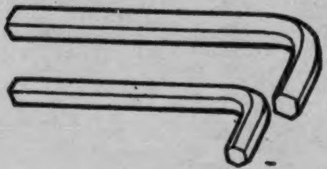
OPEN END



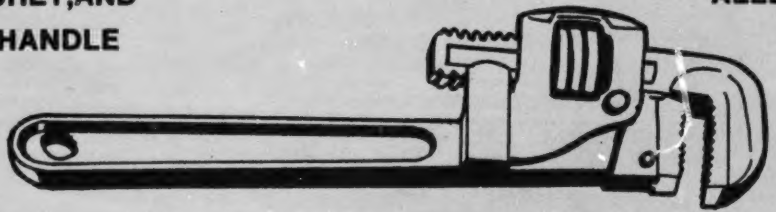
ADJUSTABLE



SOCKET,RATCHET,AND
BREAKOVER HANDLE

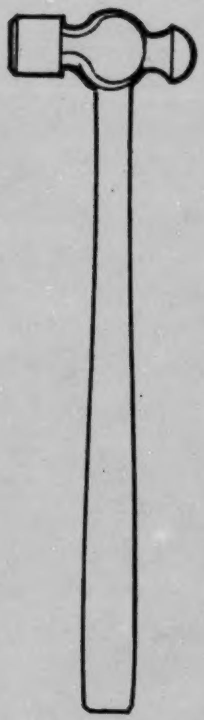


ALLEN WRENCHES

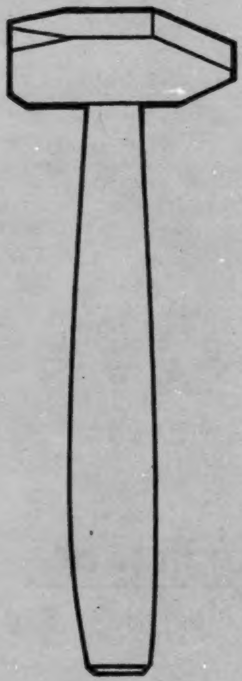


PIPE WRENCH

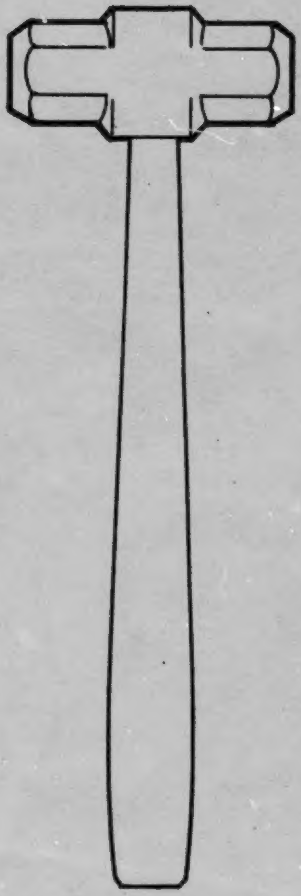
TYPES OF HAMMERS



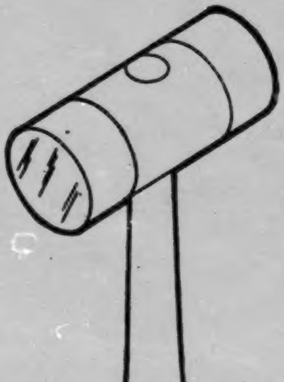
BALL PEEN



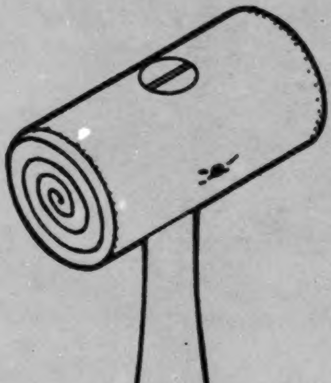
BLACKSMITH



SLEDGE

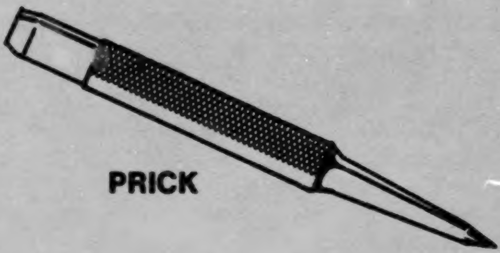


PLASTIC OR SOFT-FACED

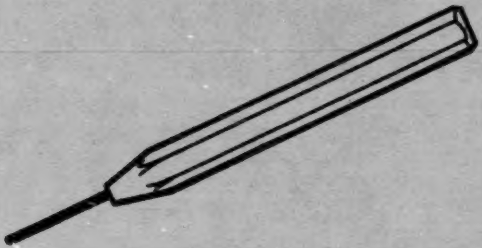


RAWHIDE MALLET

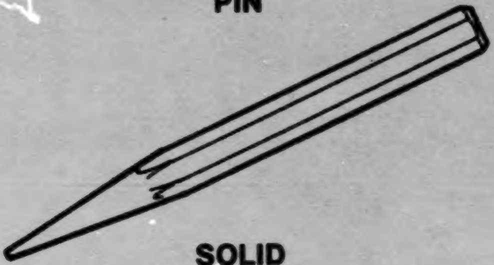
PUNCHES AND CHISELS



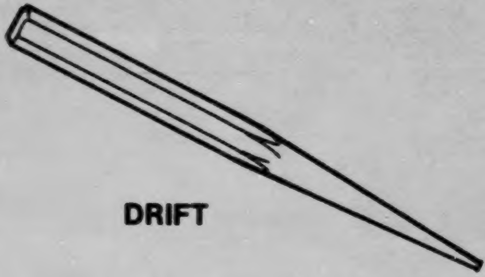
PRICK



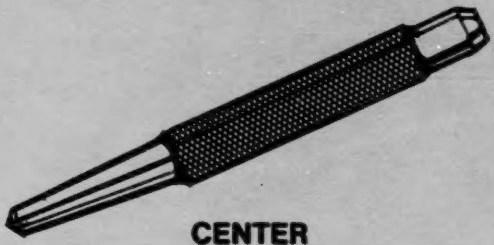
PIN



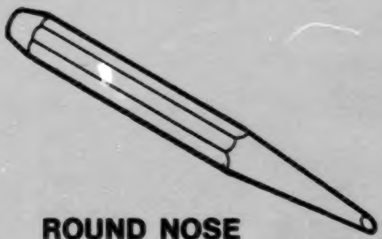
SOLID



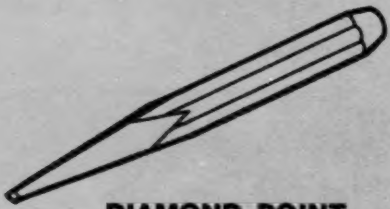
DRIFT



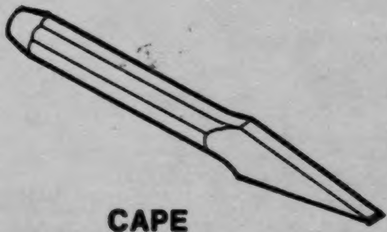
CENTER



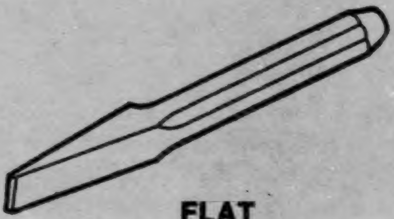
ROUND NOSE



DIAMOND POINT

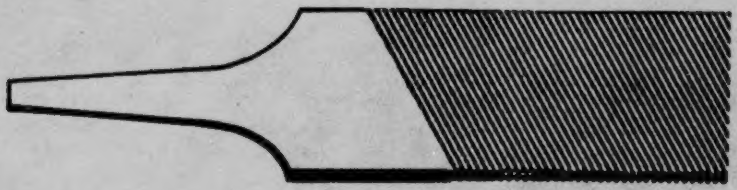


CAPE

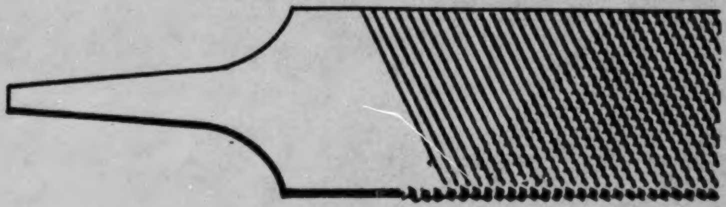


FLAT

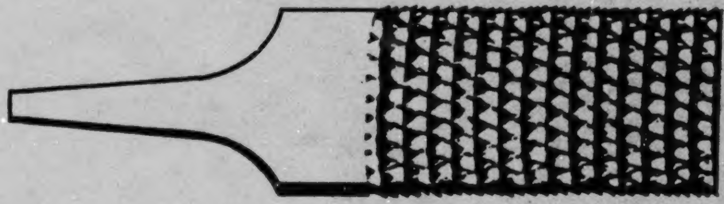
TYPES OF FILES



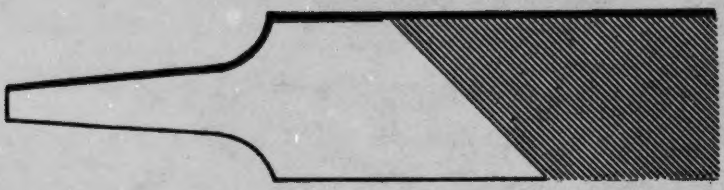
MACHINIST



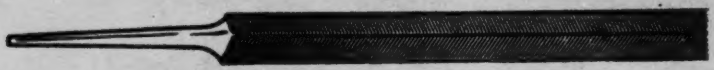
MILL



RASP

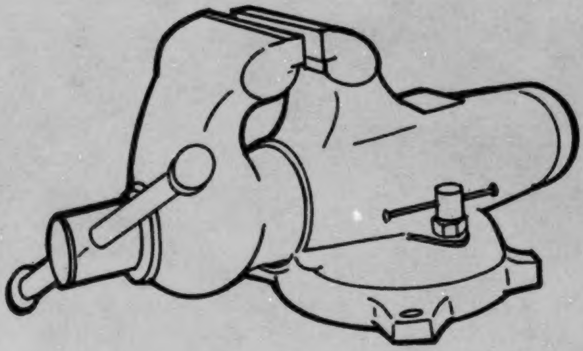


LATHE

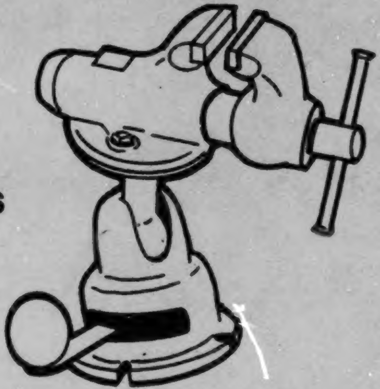


JEWELERS

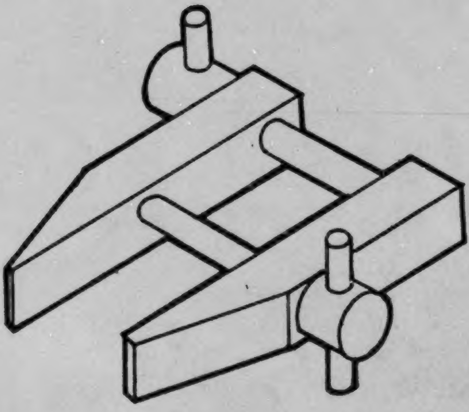
CLAMPING DEVICES



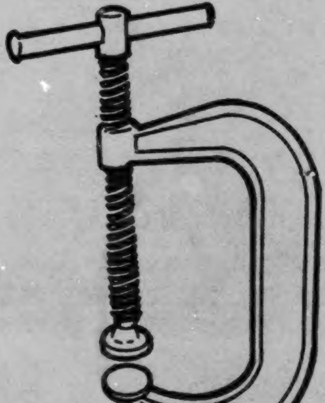
MACHINIST



TOOL MAKERS



PARALLELS



C-CLAMP

CAUSES OF HAND TOOL INJURIES

1. DEFECTIVE TOOLS

2. USE OF WRONG TOOL FOR THE JOB

3. INCORRECT USE

4. POOR TOOL STORAGE

TAP DRILL SIZES

FRACTION OR DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
80	.0135	
79	.0145	
1/64	.0156	
78	.0160	
77	.0180	
76	.0200	
75	.0210	
74	.0225	
73	.0240	
72	.0250	
71	.0260	
70	.0280	
69	.0292	
68	.0310	
1/32	.0312	
67	.0320	
66	.0330	
65	.0350	
64	.0360	
63	.0370	
62	.0380	
61	.0390	
60	.0400	
59	.0410	
58	.0420	
57	.0430	
56	.0465	
3/64	.0469	0-80
55	.0520	
54	.0550	
53	.0595	1-64, 72
1/16	.0625	
52	.0635	
51	.0670	
50	.0700	2-56, 64
49	.0730	
48	.0760	
5/64	.0781	
47	.0785	3-48
46	.0810	
45	.0820	3-56
44	.0860	
43	.0890	4-40
42	.0935	4-48
3/32	.0938	
41	.0960	
40	.0980	

FRACTION OR DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
39	.0995	
38	.1015	5-40
37	.1040	5-44
36	.1065	6-32
7/64	.1094	
35	.1100	
34	.1110	
33	.1130	6-40
32	.1160	
31	.1200	
1/8	.1250	
30	.1285	
29	.1360	8-32, 36
28	.1405	
9/64	.1406	
27	.1440	
26	.1470	
25	.1495	10-24
24	.1520	
23	.1540	
5/32	.1562	
22	.1570	
21	.1590	10-32
20	.1610	
19	.1660	
18	.1695	
11/64	.1719	
17	.1730	
16	.1770	12-24
15	.1800	
14	.1820	12-28
13	.1850	
3/16	.1875	
12	.1890	
11	.1910	
10	.1935	
9	.1960	
8	.1990	
7	.2010	1/4-20
13/64	.2031	
6	.2040	
5	.2055	
4	.2090	
3	.2130	1/4-28
7/32	.2188	
2	.2210	
1	.2280	
A	.2340	

FRACTION OR DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
15/64	.2344	
B	.2380	
C	.2420	
D	.2460	
1/4 — E	.2500	
F	.2570	5/16-18
G	.2610	
17/64	.2656	
H	.2660	
I	.2720	5/16-24
J	.2770	
K	.2810	
9/32	.2812	
L	.2900	
M	.2950	
19/64	.2969	
N	.3020	
5/16	.3125	3/8-16
O	.3160	
P	.3230	
21/64	.3281	
Q	.3320	3/8-24
R	.3390	
11/32	.3438	
S	.3480	
T	.3580	
23/64	.3594	
U	.3680	7/16-14
3/8	.3750	
V	.3770	
W	.3860	
25/64	.3906	7/16-20
X	.3970	
Y	.4040	
13/32	.4062	
Z	.4130	
27/64	.4219	1/2-13
7/16	.4375	
29/64	.4531	1/2-20
15/32	.4688	
31/64	.4844	9/16-12
1/2	.5000	
33/64	.5156	9/16-18
17/32	.5312	5/8-11
35/64	.5469	
9/16	.5625	
37/64	.5781	5/8-18

FRACTION OR DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
19/32	.5938	
39/64	.6094	
5/8	.6250	
41/64	.6406	
21/32	.6562	3/4-10
43/64	.6719	
11/16	.6875	3/4-16
45/64	.7031	
23/32	.7188	
47/64	.7344	
3/4	.7500	
49/64	.7656	7/8-9
25/32	.7812	
51/64	.7969	
13/16	.8125	7/8-14
53/64	.8281	
27/32	.8438	
55/64	.8594	
7/8	.8750	1-8
57/64	.8906	
29/32	.9062	
59/64	.9219	
15/16	.9375	1-12
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8-7
1	1.0000	
1 3/64	1.0469	1 1/8-12
1 7/64	1.1094	1 1/4-7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4-12
1 7/32	1.2188	1 3/8-6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8-12
1 11/32	1.3438	1 1/2-6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2-12
1 1/2	1.5000	

PIPE THREAD SIZES

THREAD	DRILL	THREAD	DRILL
1/8-27	R	1 1/2-11 1/2	1 47/64
1/4-18	7/16	2-11 1/2	2 7/32
3/8-18	37/64	2 1/2-8	2 5/8
1/2-14	23/32	3-8	3 1/4
3/4-14	59/64	3 1/2-8	3 3/4
1-11 1/2	1 5/32	4-8	4 1/4
1 1/4-11 1/2	1 1/2		

UNIT I

HAND TOOLS

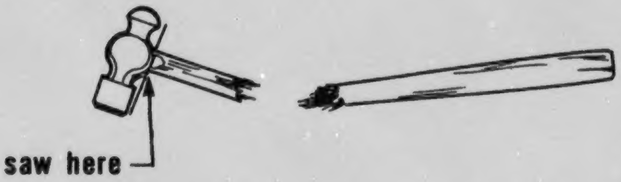
JOB SHEET 1--REPLACE A BALL PEEN HAMMER HANDLE

I. Tools and and materials

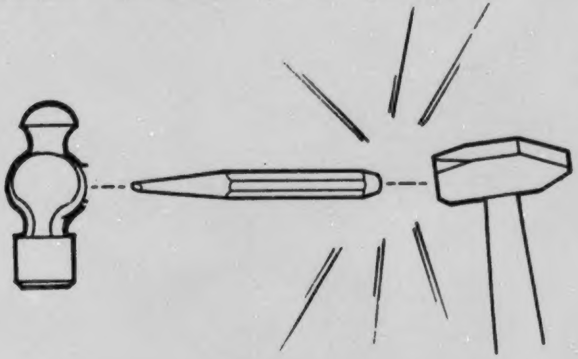
- A. Soft-faced hammer
- B. Rasp
- C. New hammer handle
- D. Wedge (wooden or metal)
- E. Hammer with broken handle
- F. Straight Punch
- G. Ball peen hammer
- H. Utility vise
- I. Hacksaw

II. Procedure

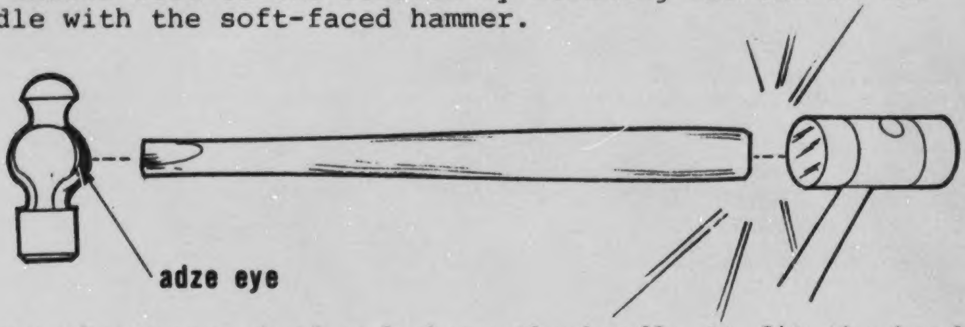
- A. Place the hammer with the broken handle into the vise.
- B. Saw off the broken portion of the handle as close to the hammer head as possible.



- C. Punch the remaining portion of the handle out the top of the hammer head using the punch.



D. Place the new hammer handle against the adze eye and mark the excess wood to the removed by striking the end of the handle with the soft-faced hammer.

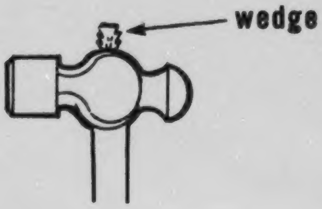


E. Remove the excess wood and shape the handle to fit the head using the rasp.

F. Using the soft-faced hammer, tap the handle into the hammer head until it fits snuggly.

G. Saw off any excess handle extending from the top of the hammer head.

H. Drive the wedge into the handle at the top of the hammer head.



I. Clean up work area.

HAND TOOLS

JOB SHEET 2--RESHAPE A COMMON SCREWDRIVER

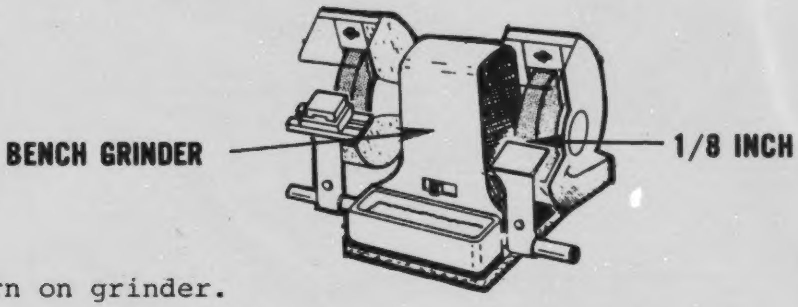
I. Tools and materials

- A. Common screwdriver (needing reshaping)
- B. Bench grinder
- C. Water tray
- D. Safety glasses

II. Procedure

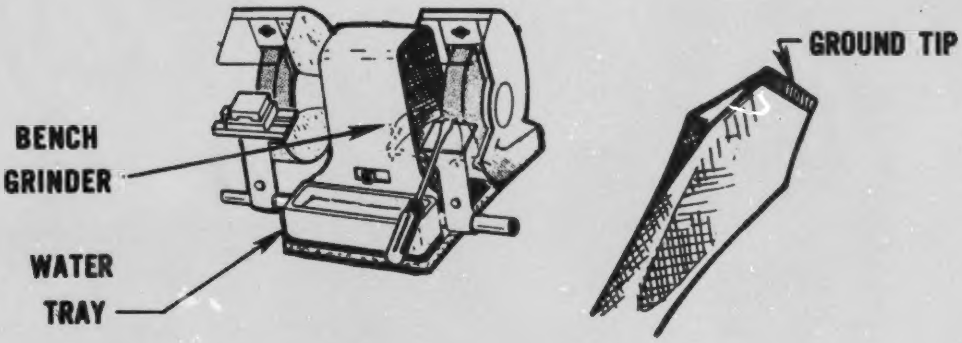
- A. Put on safety glasses.
- B. Adjust the clearance of the tool rest.

  (NOTE: Proper clearance is approximately 1/8 inch from the grinding wheel.)



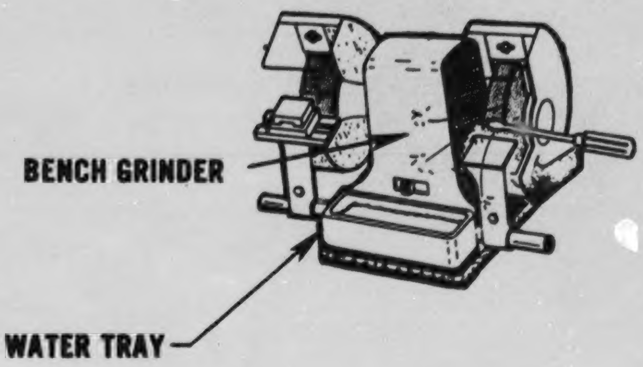
- C. Turn on grinder.
- D. Grind the end of the tip of the blade flat.

  (CAUTION: Do not grind on the side of the wheel.)



E. Grind sides of screwdriver blade so it will correctly fit the screw slot.

(NOTE: Cool tip often in water to prevent softening the tip.)



F. Turn off grinder and clean up work area.

UNIT I

HAND TOOLS

JOB SHEET 3--RESHAPE A MUSHROOMED CHISEL OR PUNCH

I. Tools and materials

  A. Mushroomed chisel or punch

  B. Bench grinder

  C. Water tray

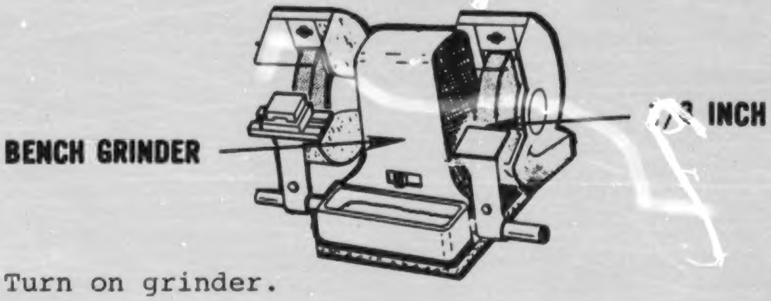
  D. Safety glasses

II. Procedure

  A. Put on safety glasses.

  B. Adjust the clearance of the tool rest.

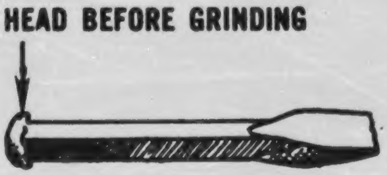
  (NOTE: Proper clearance is approximately 1/8 inch from the grinding wheel.)

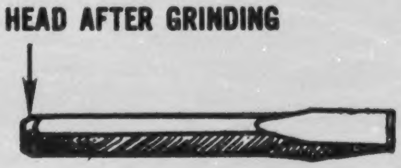


  C. Turn on grinder.

  D. Grind a 45-degree bevel on the head.

  (CAUTION: Do not grind on the side of the wheel.)





  E. Turn off grinder and clean up work area.

UNIT I

HAND TOOLS

JOB SHEET 4--SHARPEN A COLD CHISEL

I. Tools and materials

A. Chisel with dull edge

B. Bench grinder

C. Water tray

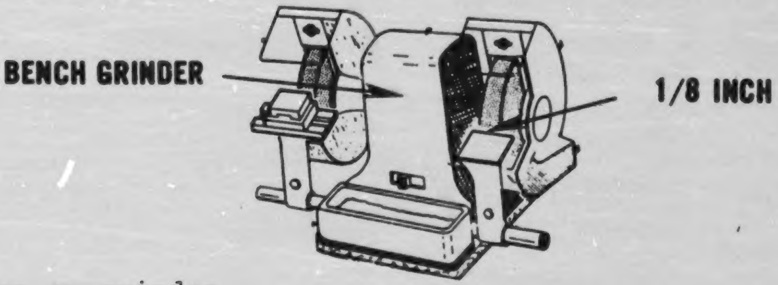
D. Safety glasses

II. Procedure

A. Put on safety glasses.

B. Adjust clearance of tool rest.

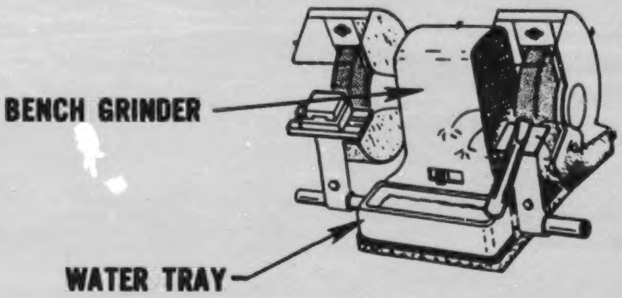
(NOTE: Proper clearance is approximately 1/8 inch from the grinding wheel.)



C. Turn on grinder.

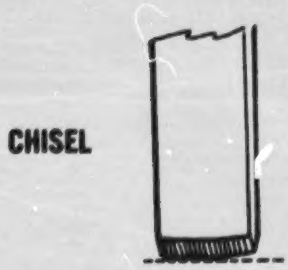
D. Hold the chisel with a firm grip and apply the chisel with very little pressure against the wheel.

(NOTE: Light pressure prevents the cutting edge of the chisel from over heating.)

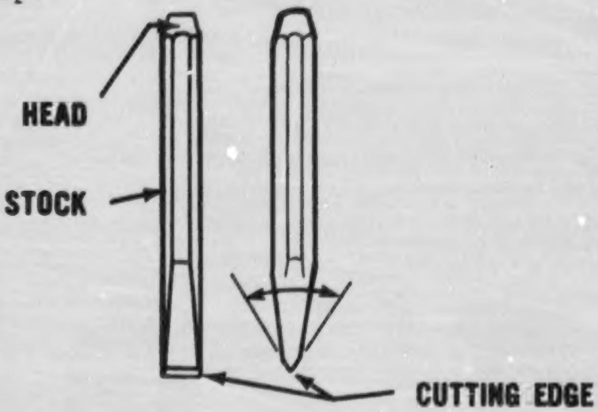


E. Dip the chisel in the water frequently to cool.

F. Grind the cutting edge at a slight curve.



G. Grind each side at the 60-degree angle until the cutting edge is sharp.



H. Turn off grinder and clean up work area.

UNIT I

HAND TOOLS

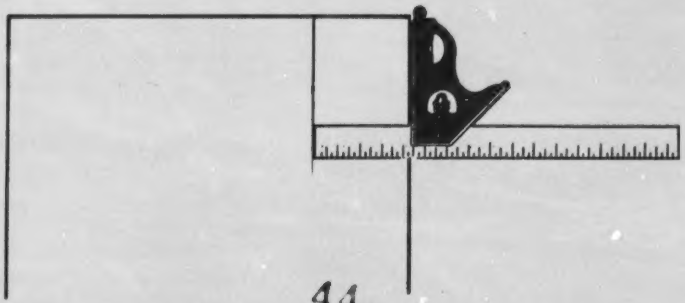
JOB SHEET 5--DRILL AND TAP A BLIND HOLE

I. Tools and materials

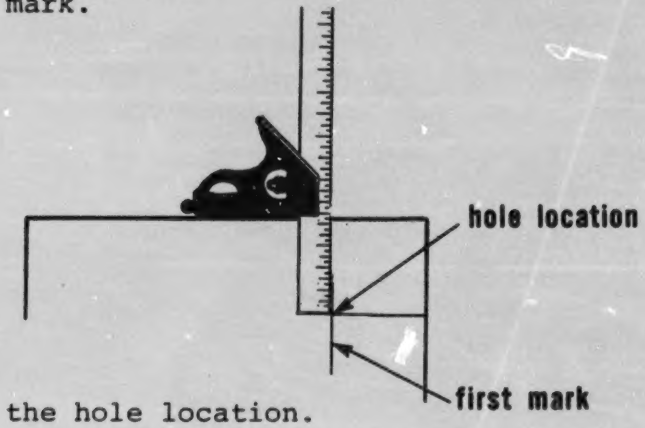
- A. Bar stock (at least 1½" thick)
- B. ½-13-NC Taper tap
- C. ½-13-NC Plug tap
- D. ½-13-NC Bottoming tap
- E. Threading oil
- F. Brush
- G. Tap wrench
- H. Shop rag
- I. Drill index
- J. Combination square
- K. Layout dye
- L. Scriber
- M. Centerpunch
- N. Ballpeen hammer
- O. Drill press

II. Procedures

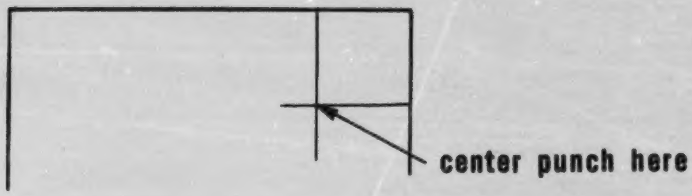
- A. Layout the center point for the hole location.
  1. Lightly coat the surface of the metal with layout blue.
  2. Set the square head to the correct distance from one edge of the metal for the hole location and scribe a mark.



3. Set the square head to the correct distance from the other edge of the metal for the hole location and scribe a mark.



B. Center punch the hole location.



C. Drill the hole one inch deep.

1. Select the tap drill size for the ½-13-NC tap.

   (NOTE: See Transparency 9--TAP DRILL SIZES)

2. Place the drill bit in the drill press and select the correct speed.

3. Place the workpiece in the drillpress vise and align the center point of the hole with the point of the drill.

   (CAUTION: Secure the workpiece and vise to the table.)

4. Set the depth stop on the drill press to allow for one inch drilling depth.

5. Start the drill press and drill the hole.

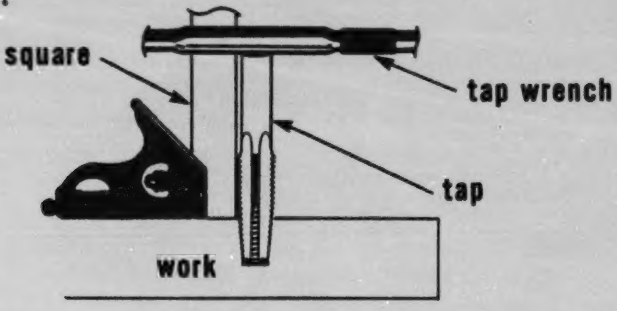
   (NOTE: Use cutting oil to cool the drill bit.)

D. Tap the hole with the taper tap.

1. Place the taper tap in the tap wrench.

2. Start the tap in the hole.

3. Check the tap for squareness with the combination square.



5. Turn the tap ½ turn and then back ¼ turn.

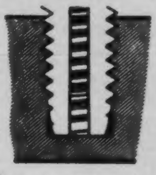
   (NOTE: This breaks the chips and allows smoother threading.)

6. Keep the tap moist with cutting oil.

7. Repeat the turning process until the tap reaches the bottom of the hole.

8. Back the tap out and remove the chips.

plug tap



E. Tap the hole with the plug tap.

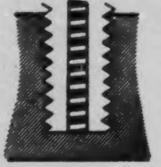
   1. Place the plug tap in the tap wrench.

   2. Turn the tap in the hole until it reaches the unthreaded part of the hole.

   3. Use the same threading process as before until the tap reaches the bottom of the hole.

   4. Back the tap out and remove the chips.

bottoming tap



F. Tap the hole with the bottoming tap.

   1. Place the bottoming tap in the tap wrench.

   2. Turn the tap until it reaches the unthreaded part of the hole.

   3. Use the same threading process as before until the tap reaches the bottom of the hole.

   4. Back out the tap and remove the chips.

G. Clean up the work area and turn in your tools.

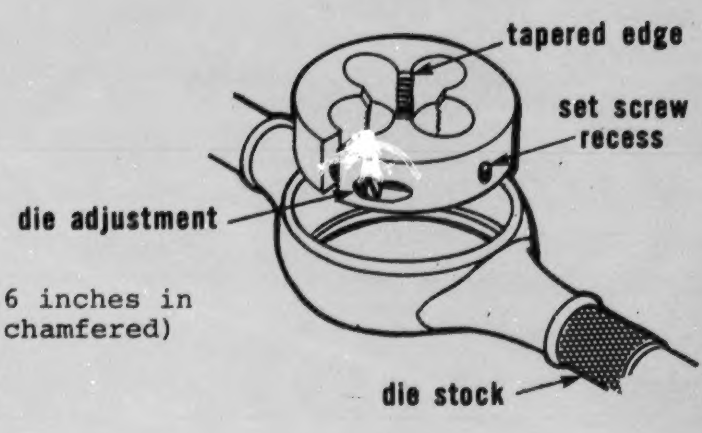
H. Hand in your workpiece to your instructor.

UNIT I

HAND TOOLS

JOB SHEET 6--THREAD A SHAFT

I. Tools and materials

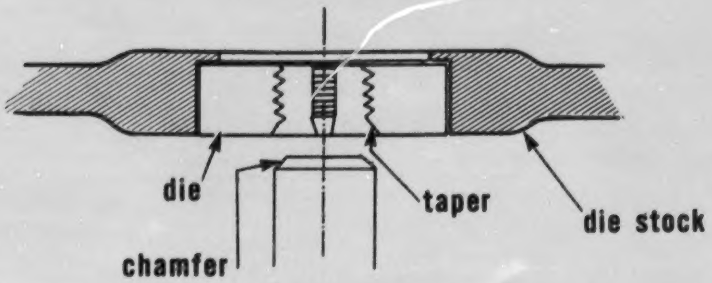


- A. Die stock
- B. ½-13-NC die
- C. Cutting oil
- D. Shop rag
- E. ½ inch round stock (6 inches in length with one end chamfered)
- F. Scriber
- G. 6-inch rule
- H. Vise

II. Procedures

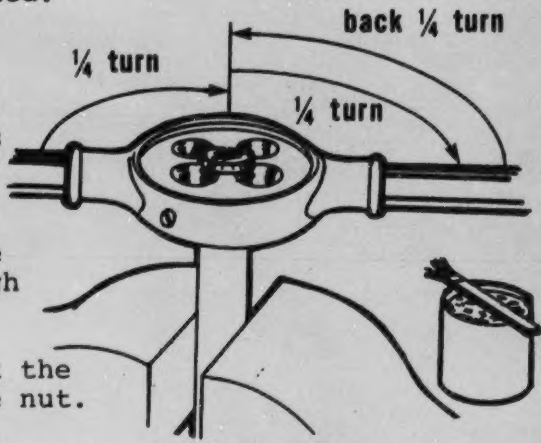
- A. Place the workpiece in the vise
- B. Mark off the length to be threaded
- C. Insert the dies in the diestock and tighten set screws securely
- D. Place the die on the chamfered end of the workpiece.

  (NOTE: Start the side of the die that has tapered threads or has "Start this side" marked on it.)



E. Apply cutting oil on the workpiece several times during threading.

F. Start the die threading onto the workpiece by pushing down on the diestock as it is turned.



G. Turn the diestock ½ turn and then back ¼ turn.

(NOTE: This breaks the chips and allows smoother threading.)

H. Repeat this process until the workpiece just extends through the die.

I. Remove the diestock and check the threads with the correct size nut.

J. Adjust the die if the threads are too tight or loose.

K. Complete the threading process to the mark on the workpiece.

L. Clean up the work area and turn in tools.

M. Turn in the workpiece to your instructor.

UNIT I

HAND TOOLS

TEST PART 1

1. Match the terms associated with handtools to the correct definition by placing the number of each term on the right in the correct blank on the left.

_____a. A surface on a file that has only one cutting angle.

_____b. A surface on a file that has two cutting angles which cross.

_____c. The tightness of a threaded bolt in a hole.

_____d. Screws smaller than ¼ inch in diameter.

_____e. Refers to the number of threads per inch on a specific size of a bolt.

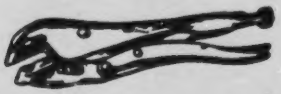
1. Single-cut
2. Thread-fit
3. Machine screw
4. Thread series
5. Double-cut

2. Identify the types of pliers by writing each name listed below by the correct tool.

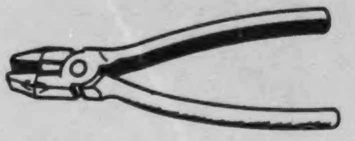
Slip joint
Vise grip
Needle nose

Channel lock
Side cutters
Diagonals

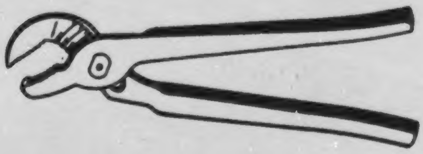
a.______________________________



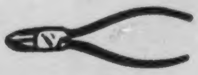
b.______________________________



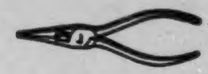
c.______________________________



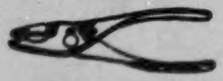
d.______________________________



e. ______________________________



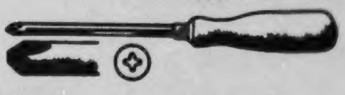
f. ______________________________



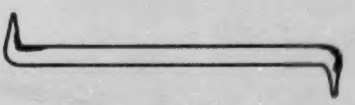
3. Identify the types of screwdrivers by writing each name listed below over the correct tool.

Common
Phillips
Offset

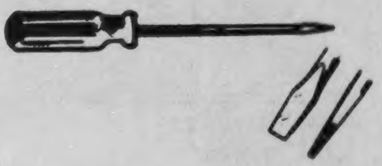
a. ______________________________



b. ______________________________



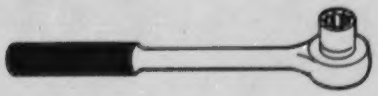
c. ______________________________



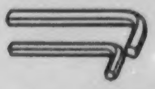
4. Identify the types of wrenches by writing each name listed below under the correct tool.

Open-end
Adjustable
Box-end
Socket
Pipe wrench
Allen
Combination

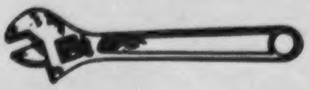
a. ______________________________



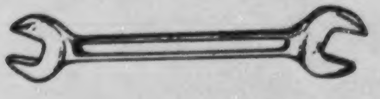
b. ______________________________



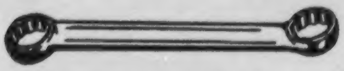
c. ______________________________



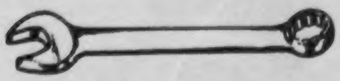
d. ______________________________



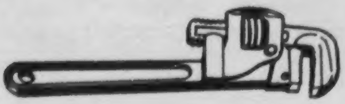
e. ______________________________



f. ______________________________



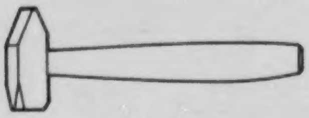
g. ______________________________



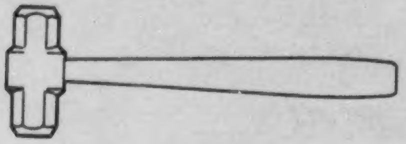
5. Identify the types of hammers by writing each name listed below by the correct tool.

Ball peen	Sledge
Mallet	Blacksmith

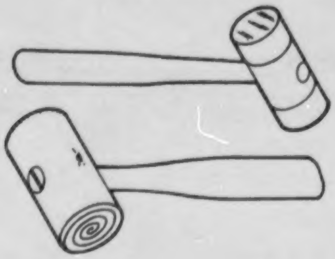
a. ________________________



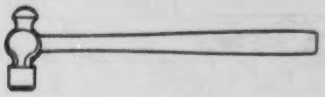
b. ________________________



c. ________________________



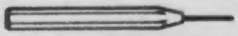
d. ________________________



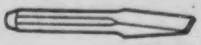
6. Identify the types of punches and chisels by writing each name listed below by the correct tool.

PUNCHES	CHISELS
Center	Flat cold
Drift	Diamond point
Prick	Round nose
Solid	Cape
Pin	

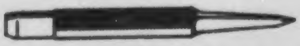
a. ________________________



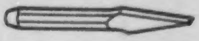
b. ________________________



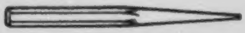
c. ________________________



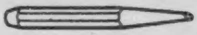
d. ________________________



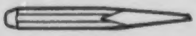
e. ______________________________



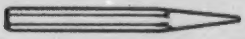
f. ______________________________



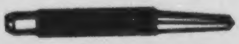
g. ______________________________



h. ______________________________



i. ______________________________



7. Identify the types of files according to their use by writing the number of each on the right in the correct blank on the left.

_____a. Files of varied shapes used by tool and die makers.

_____b. A file used for plastics and soft metals.

_____c. A file used for general filing when a smooth finish is needed.

_____d. A double-cut file used to remove metal quickly.

_____e. A long angle single-cut file used for filing a rotating workpiece.

1. Mill file
2. Machinist file
3. Jewelers file
4. Rasp
5. Lathe file

8. Identify the types of threading tools by writing each name listed below under the correct tool.

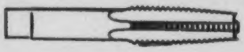
Die
Taper

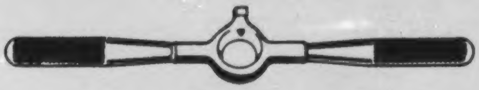
Die stock
Tap wrench

Thread restorer

a. ______________________________

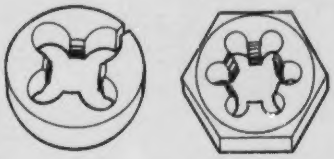
b. ______________________________

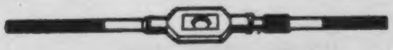




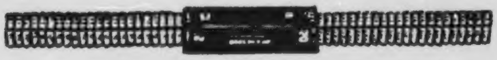
c. ______________________________

d. ______________________________





e. ______________________________



9. Identify the types of squares by writing each name listed below over the correct tool.

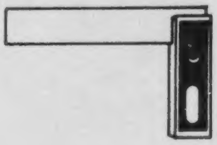
Combination

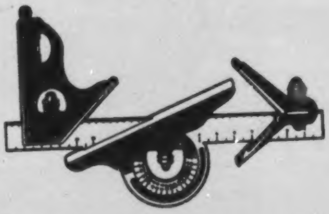
Steel

Try

a. ______________________________

b. ______________________________





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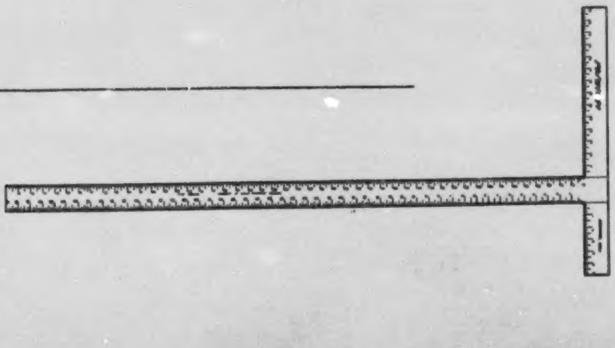
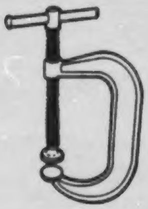


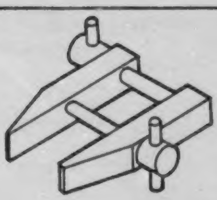
10. Identify the types of clamping devices by writing each name listed below by the correct tool.

Machinist vise	Toolmakers vise
Parallel clamp	C-Clamp

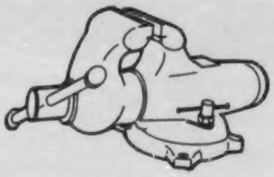
a. ______________________________



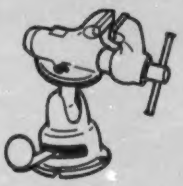
b. ______________________________



c. ______________________________



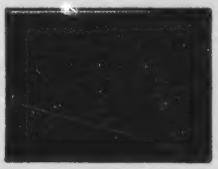
d. ______________________________



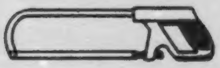
11. Identify other handtools by writing each name listed below by the correct tool.

Hacksaw	Emery cloth

a. ______________________________



b. ______________________________



UNIT I

HAND TOOLS

TEST PART 2

1. Point out the basic causes of handtool accidents by placing a "✓" in front of each listed below.

_____a. Defective tools

_____b. Using tools carefully

_____c. Using the wrong tool for the job

_____d. Incorrect method of using the tool

_____e. Improper tool storage and care

_____f. Use of tools for long periods of time

2. Select the correct rules to follow when using handtools by writing "Yes" in front of correct statements and "No" in front of incorrect statements.

_____a. Select any tool that looks like it would work for a job.

_____b. Learn how to use tools properly.

_____c. Make sure tools are in good condition and properly sharpened.

_____d. Keep tools clean and dry.

_____e. Keep sharp-edged tools near the edge of the table so they can easily be seen.

_____f. Use tools without handles very carefully.

_____g. Saw lightly when nearing the completion of a cut with a hacksaw.

_____h. Strike hardened chisels with hard-faced hammers only.

_____i. Push on wrenches that don't fit properly and pull on those that do fit properly.

_____j. Tell your instructor about any faulty or broken tools.

UNIT I

HAND TOOLS

ANSWERS TO TEST

Part 1

1. a. 1
   b. 5
   c. 2
   d. 3
   e. 4
2. a. Visegrip
   b. Side cutters
   c. Channellock
   d. Diagonals
   e. Needlenose
   f. Slip joint
3. a. Phillips
   b. Offset
   c. Common
4. a. Socket
   b. Allen
   c. Adjustable
   d. Open-end
   e. Box-end
   f. Combination
   g. Pipe wrench
5. a. Blacksmith
   b. Sledge
   c. Mallet
   d. Ball peen
6. a. Pin
   b. Flat cold
   c. Prick
   d. Cape
   e. Drift
   f. Round nose
   g. Diamond point
   h. Solid
   i. Center
7. a. 3
   b. 4
   c. 1
   d. 2
   e. 5
8. a. Taper
   b. Die stock
   c. Die
   d. Tap wrench
   e. Thread restorer

9. a. Try
   b. Combination
   c. Steel

10. a. C-clamp
    b. Parallel clamp
    c. Machinist vise
    d. Toolmakers vise

11. a. Emery cloth
    b. Hacksaw

Part 2

1. a. ✓
   b.
   c. ✓
   d. ✓
   e. ✓
   f.

2. a. No
   b. Yes
   c. Yes
   d. Yes
   e. No
   f. No
   g. Yes
   h. No
   i. No
   j. Yes

UNIT II

FASTENERS

UNIT OBJECTIVE

After completing this unit, the student will be able to identify terms associated with fasteners and the various types of fasteners used in a machine shop. This knowledge will be evidenced through demonstration and by satisfactorily completing a unit test.

SPECIFIC OBJECTIVE

After completion of this unit, the student will be able to:

1. Match terms associated with fasteners to the correct definition.
2. Identify the types of fasteners commonly used in a machine shop.

UNIT II

FASTENERS

SUGGESTED TEACHING ACTIVITIES

I. Objective sheet

- A. Discuss the unit objective with the students
- B. Discuss each specific objective with the students
- C. Have the students complete the objectives in the most logical sequence for shop organization
- D. Add any objectives necessary

II. Information and assignment sheets

- A. Make a display of various types of fasteners used in the shop
- B. Discuss the use of different fasteners
- C. Show students applications of fasteners within the shop
- D. Have students complete the following assignment sheets to reinforce this area of information:
    1. ASSIGNMENT SHEET 1--SELECTING FASTENERS
    2. ASSIGNMENT SHEET 2--CONSTRUCT A FASTENER DISPLAY

       (NOTE: This may be done as a group project and displayed on the wall for future reference.)

III. Transparency masters

(NOTE: Transparency masters are included in the student manuals as information sheets.)

- A. TM-1--COMMON SHOP BOLTS
- B. TM-2--SPECIALTY BOLTS
- C. TM-3--TYPES OF NUTS
- D. TM-4--TYPES OF WASHERS
- E. TM-5--TYPES OF SCREW HEADS
- F. TM-6--TYPES OF SCREWS
- G. TM-7--OTHER FASTENERS

IV. Answers to assignment sheets

A. Discuss the correct uses of the fasteners

B. Review problem areas pointed out by assignment sheets.

C. Encourage total student participation in constructing a fastener display.

(NOTE: Contests often encourage participation.)

V. Unit test

A. The unit test is a one part test covering the information sheet.

B. Various approaches may be used to test over fasteners:

1. The fastener display may be used to check the students knowledge about the various fasteners.

2. Students may be asked to identify fasteners used on machines in the shop.

3. The test provided in this unit may be used as an assignment sheet.

VI. Answers to the test

A. Answers are based on total information covered in the unit.

B. For convenience in grading, make corresponding answer sheets for test parts added.

VII. References

A. McCarthy and Smith. Machine Tool Technology. McKnight and McKnight. Bloomington, Illinois, 3rd ed., 1968.

B. Walker, John. Modern Metalworking. Goodheart-Wilcox, 123 W. Taft Drive, South Holland, Illinois, 60473.

UNIT II

FASTENERS

INFORMATION SHEET

I. Terms and definitions

  A. Locknut--Term applied to the outer of two nuts on a bolt when tightened together.

  B. Peening--Spreading metal into a flat or rounded shape.

  C. Nut--Small metal block which is drilled and threaded to fit a bolt.

  D. Cotterpin--A wire-like pin which is used with slotted nuts to prevent them from turning on the shaft.

  E. Handtight--A nut or bolt that has been tightened by hand and not with a wrench.

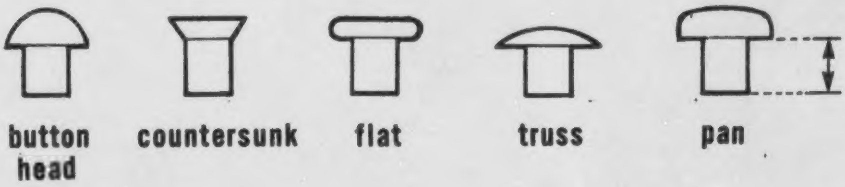
II. Types of fasteners

  A. Rivets--A metal pin with a head on one end that is placed through holes in metal and peened into place.

    1. Rivets are made of several types of metals.

    EXAMPLES: Aluminum, brass

    2. Rivets vary in shapes and sizes.



    3. Riveting equipment

      a. Ball peen hammer

      b. Rivet set

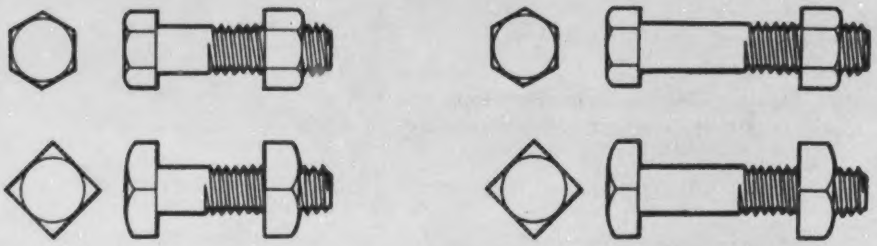
      c. Riveting block

      d. Pop rivets

B. Bolts--Metal threaded fasteners which may be used in threaded holes or with a nut.

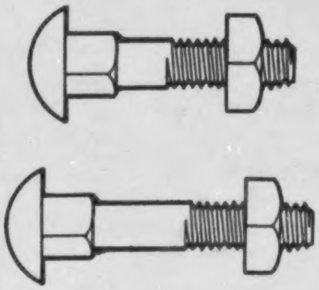
1. Machine--Made for assembly of machine work

   (NOTE: They are available in a hexagon and square head shape.)



2. Stove--Used to fasten light metal parts.

3. Carriage--A round-headed bolt with a square neck which keeps the bolt from turning in the hole when the nut is tightened.



4. Special purpose--Bolts designed for a specific use.

   a. U-bolt
   b. Eye bolt
   c. Turnbuckle
   d. J-bolt
   e. Expansion bolt
   f. Anchor bolt
   g. Toggle bolt
   h. Lag bolt

C. Nuts--Used with bolts when parts do not have threaded holes.

   1. Standard or hexagon--Used on machine bolts.
   2. Jam--Used to lock a standard nut in place.
   3. Castle or slotted--Used with a bolt that has a hole through the threads so that a cotter pin may be used to lock the nut in place.
   4. Acorn--Used when the threaded end of the bolt is to be protected or dressed up.
   5. Wing--Used when the nut must be tightened and loosened by hand.

D. Washers--Used to spread the clamping pressure evenly over a larger area and to prevent damaging the surface of the workpiece.

   1. Flat--Are available in various shapes and sizes.
   2. Lock--Prevents the bolt from loosening during vibration.
   3. Internal and external lock--Used for special assembly when different locking requirements are needed.
   4. Countersunk--Used with countersunk holes in threaded parts.

E. Machine screws--Used in general assembly of parts and machine tools.

   (NOTE: Screws come in a variety of sizes and head shapes.)

   1. Cap--Used in assembly where a quality and finished appearance is required.
   2. Machine--Similar to machine bolts but smaller in diameter and length.
   3. Sheetmetal (Thread forming or thread cutting)--Used in assembly of sheetmetal that is not threaded.
   4. Setscrews--Used in recessed or hidden locations such as for holding pulleys on shafts.
   5. Drive--Permanent type screws that are driven into a drilled or punched hole.

F. Other fasteners

   1. Cotter pins (retaining pins)--Placed in a drilled hole in a shaft to keep a part in place.

   a. Standard
   b. Hitch
   c. Hump
   d. Clinch

2. Snap rings (retaining rings)--Used in internal and external grooves.

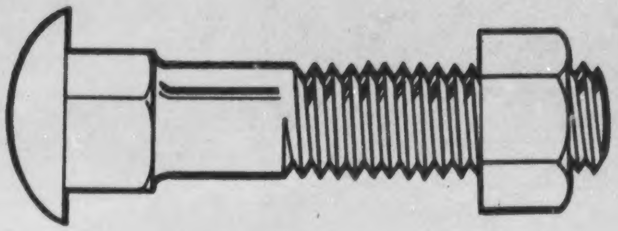
3. Keys--Used to hold gears or pulleys securely on shafts.

   a. Square
   b. Gib head
   c. Pratt and Whitney
   d. Woodruff

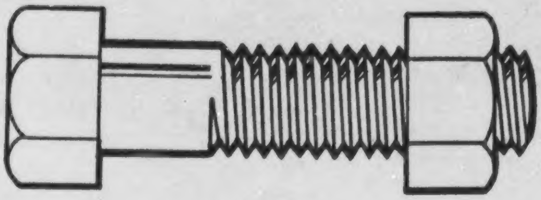
4. Dowel pins

   a. Spring
   b. Knurled
   c. Shearproof
   d. Shear

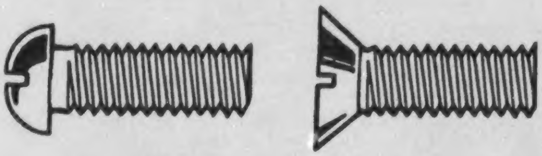
COMMON SHOP BOLTS



CARRIAGE

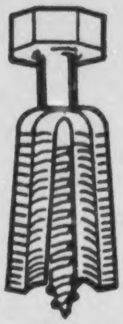


MACHINE

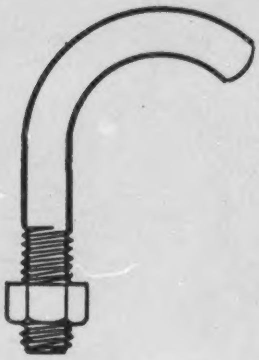


STOVE

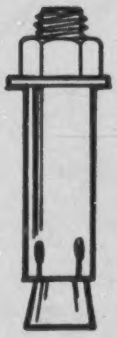
SPECIALTY BOLTS



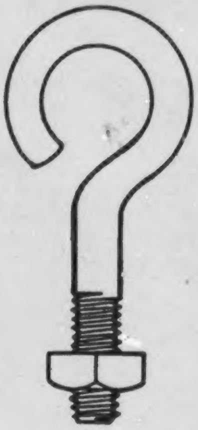
EXPANSION



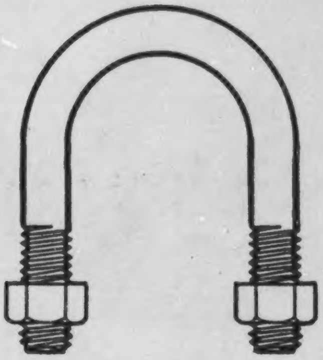
J-BOLT



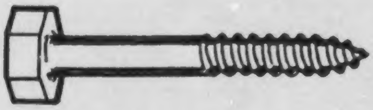
ANCHOR



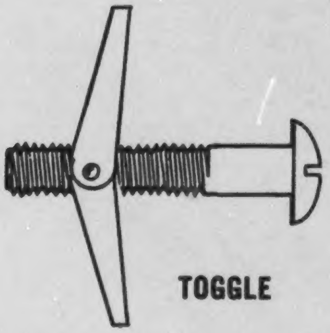
EYE



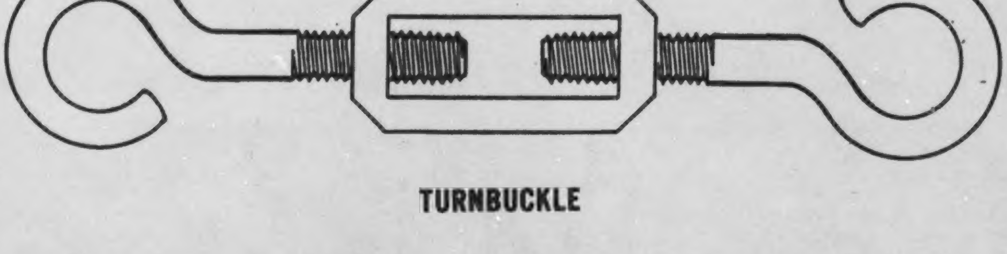
U-BOLT



LAG

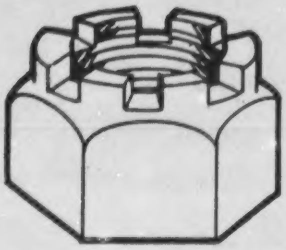


TOGGLE

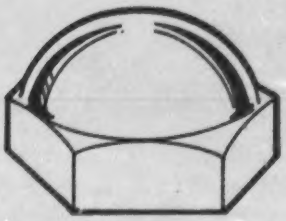


TURNBUCKLE

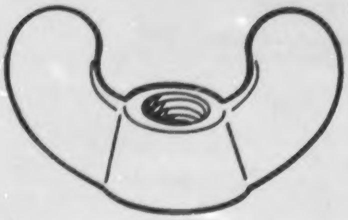
TYPES OF NUTS



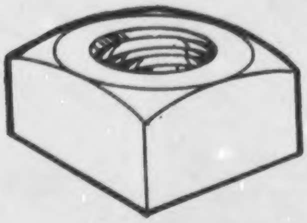
CASTLE



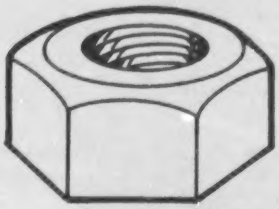
CAP



WING

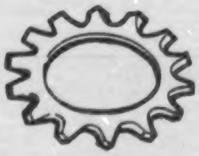


SQUARE

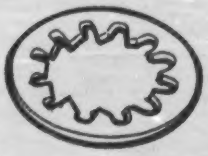


HEXAGON

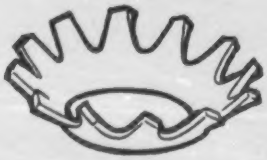
TYPES OF WASHERS



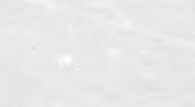
EXTERNAL LOCK



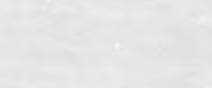
INTERNAL LOCK



COUNTERSUNK LOCK

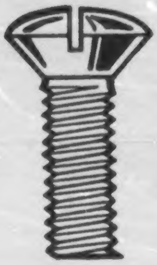


LOCK

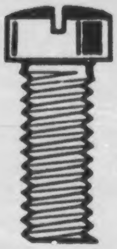


FLAT

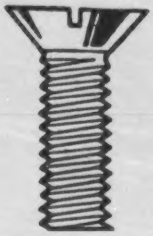
TYPES OF SCREW HEADS



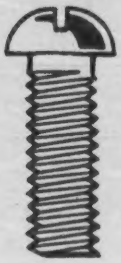
OVAL



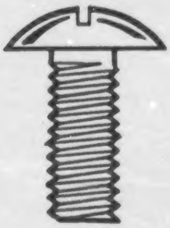
FILLISTER



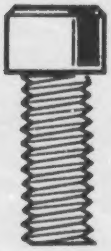
FLAT



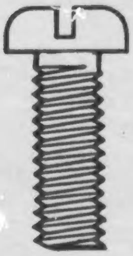
ROUND



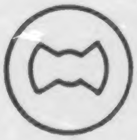
TRUSS



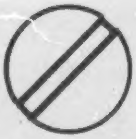
SOCKET



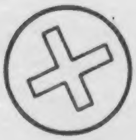
PAN



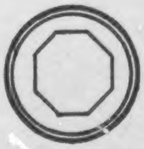
CLUTCH



SLOTTED

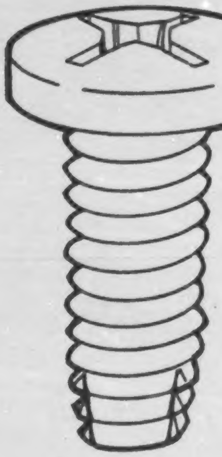


CROSSED
RECESS

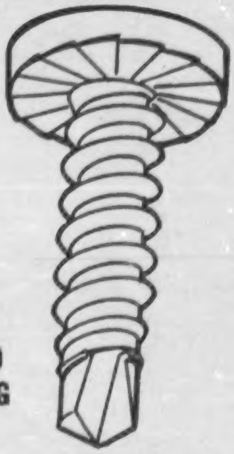


SOCKET

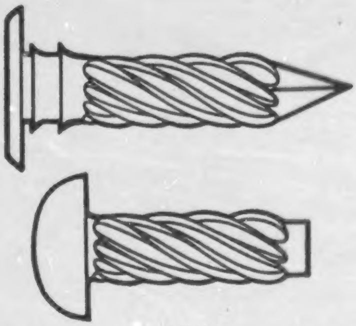
TYPES OF SCREWS



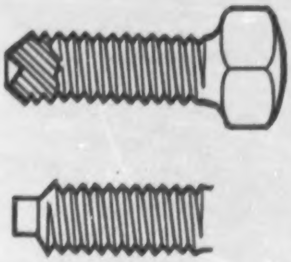
SHEETMETAL



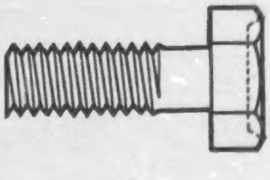
THREAD FORMING



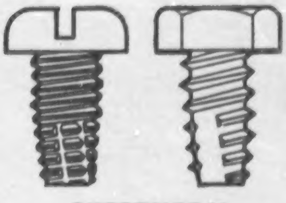
DRIVE



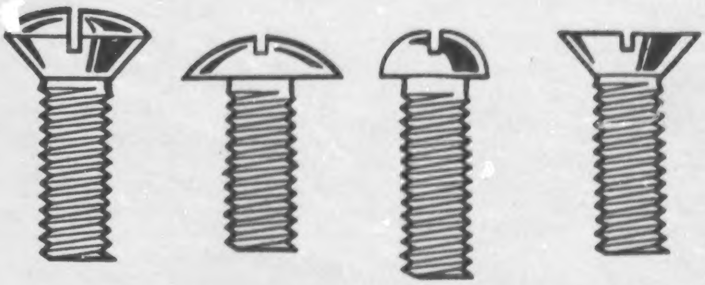
SET



CAP



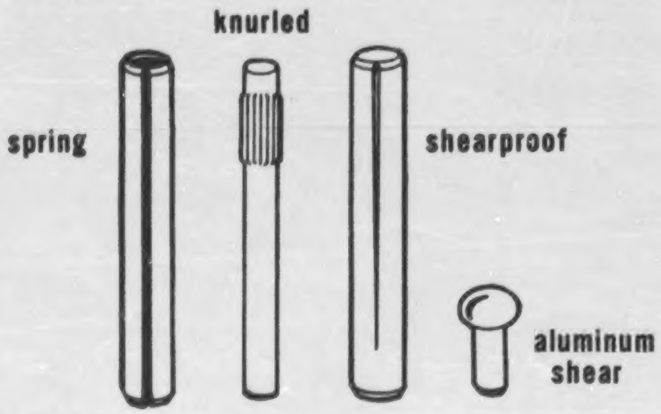
SHEETMETAL SELF-TAPING

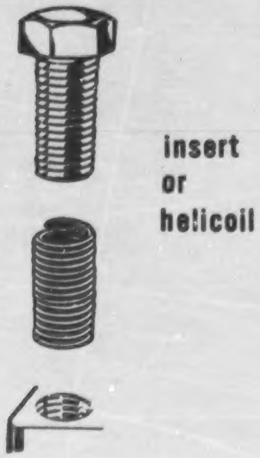


MACHINE

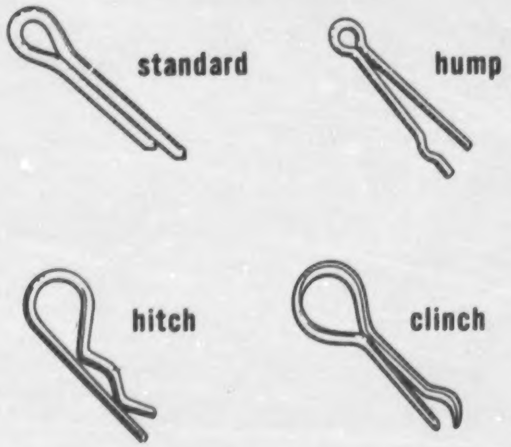
OTHER FASTENERS

DOWEL PINS

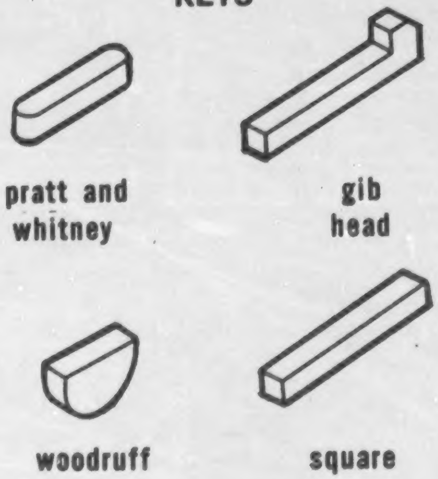




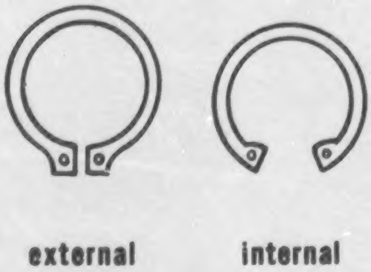
COTTER PINS



KEYS



SNAP RINGS



UNIT II

FASTENERS

ASSIGNMENT SHEET 1--SELECTING FASTENERS

Directions: Match the term on the right with the correct phrase on the left by writing the number of each term in the correct blank.

_____A. Type of bolt used to fasten light metal parts.

_____B. Bolt used in assembly of machine parts.

_____C. A metal pin with a head on one end that is placed through a hole and peened into place.

_____D. A round-headed bolt with a square neck which keeps the bolt from turning in a hole as the nut is tightened.

_____E. A nut used with a bolt that has a hole through the threads so that a cotter pin may be used to lock the nut in place.

_____F. A washer which prevents a bolt from loosening during vibration.

_____G. Pin placed in a drilled hole in a shaft to keep a part in place.

_____H. Used in internal and external grooves.

_____I. Permanent type screws that are driven into a drilled or punched hole.

_____J. Type of screw used in assembly where a quality and finished appearance is required.

_____K. A nut which may be loosened or tightened by hand.

_____L. A nut used to protect the threaded end of a bolt.

_____M. A screw used in a recessed or hidden location.

_____N. Used to hold gears and pulleys securely on shafts.

_____O. A special purpose bolt.

1. Carriage
2. Castle
3. Snap ring
4. Cotter
5. Stove
6. Cap
7. Lock
8. Machine
9. Drive
10. Rivet
11. Wing
12. Set
13. Acorn
14. Toggle
15. Key

UNIT II

FASTENERS

ASSIGNMENT SHEET 2--CONSTRUCT A FASTENER DISPLAY

Directions: Collect all the different types of fasteners you can. Arrange the fasteners in a display on a board. These may be glued or wired onto the board. Label each type of fastener.

UNIT II

FASTENERS

ANSWERS TO ASSIGNMENTS

Assignment Sheet 1

A. 5

B. 8

C. 10

D. 1

E. 2

F. 7

G. 4

H. 3

I. 9

J. 6

K. 11

L. 13

M. 12

N. 15

O. 14

Assignment Sheet 2

Evaluated to the satisfaction of the instructor.

UNIT II

FASTENERS

TEST

1. Match the terms associated with fasteners to the correct definition by placing the number of each term on the right in the correct blank on the left.

_____a. A nut or bolt that has been tightened by hand.

_____b. A small metal block which is drilled and threaded to fit a bolt.

_____c. Spreading metal into a flat or round shape.

_____d. Term applied to the outer of two nuts on a bolt when tightened together.

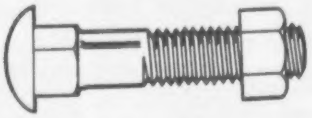
_____e. A wire-like pin which is used with slotted nuts to prevent them from turning on the shaft.

1. Cotter pin
2. Locknut
3. Handtight
4. Peening
5. Nut

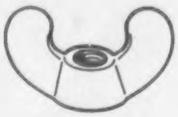
2. Identify the types of fasteners commonly used in a machine shop by writing the correct name from the list below in the blank provided.

Rivet
Machine bolt
Carriage bolt
Wing nut
Stove bolt
U-bolt
Castle nut
Lock washer
Flat washer
Machine screw
Cotterpin
Snap ring

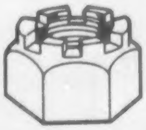
a. ______________________________



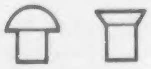
b. ______________________________

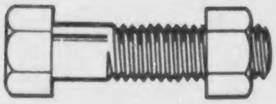


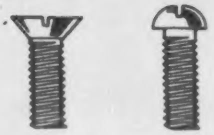
c. ______________________________



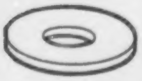
d. ______________________________

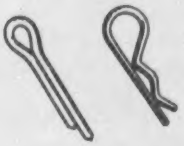




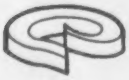


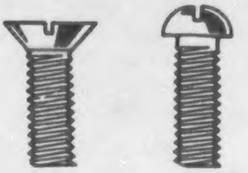
e. ______________________________ f. ______________________________



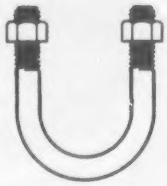


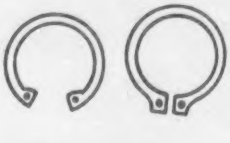
g. ______________________________ h. ______________________________





i. ______________________________ j. ______________________________





k. ______________________________ l. ______________________________

UNIT II

FASTENERS

ANSWERS TO TEST

1. a. 3
    b. 5
    c. 4
    d. 2
    e. 1
2. a. Carriage bolt
    b. Wing nut
    c. Castle nut
    d. Rivet
    e. Machine bolt
    f. Machine screw
    g. Flat washer
    h. Cotterpin
    i. Lock washer
    j. Stove bolt
    k. U-bolt
    l. Snap ring

Section B

SHEET METAL

UNIT I

SHEET METAL BASICS

UNIT OBJECTIVE

Upon completion of this unit, the student will be able to use the correct terminology and follow the safety rules associated with sheet metal work. The student will also be able to select the correct sheet metal layout, cutting, and forming tools, and equipment for sheet metal operations. This knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Point out the opportunities available in the sheet metal industry.
2. Match terms associated with sheet metal work to the correct definition.
3. Select the correct safety rules to follow when working with sheet metal.
4. Identify the measuring and layout tools used in sheet metal work.
5. Identify the types of tools used to cut sheet metal.
6. Identify the types of equipment used in sheet metal work.
7. Identify the other types of tools used in sheet metal work.
8. Identify the parts of sheet metal equipment.

UNIT I

SHEET METAL BASICS

SUGGESTED TEACHING ACTIVITIES

I. Objective sheet

  A. Discuss the unit objective with the students.

  B. Discuss each specific objective with the students.

  C. Have the students complete objectives in the most logical sequence for the shop's organization.

  D. Add any objectives that are needed.

II. Information and assignment sheets

  A. INFORMATION SHEET I--INTRODUCTION TO SHEET METAL

    1. Relate the various sheet metal opportunities to the jobs in your community.

    2. Explain the terms associated with sheet metal.

    3. Discuss safety factors related to sheet metal.

  B. INFORMATION SHEET II--HANDTOOLS AND EQUIPMENT

    1. Explain the use of the various measuring and layout tools used in sheet metal work.

    2. Discuss the operation of tools used to cut sheet metal.

    3. Discuss the operation of the various kinds of equipment used in sheet metal construction (Transparencies 1-9).

    4. Use ASSIGNMENT SHEET--IDENTIFY THE PARTS OF SHEET METAL EQUIPMENT to reinforce this area of information.

III. Transparency masters

  (NOTE: Transparencies are included in the student manual as information sheets.)

  A. TM-1--PARTS OF THE SQUARING SHEAR

  B. TM-2--THE NOTCHER

  C. TM-3--THE ROTARY CIRCLE SHEAR

  D. TM-4--PARTS OF THE BENDING BRAKE

  E. TM-5--THE BRAKE BOX

  F. TM-6--PARTS OF THE FINGER BRAKE

G. TM-7--PARTS OF THE ADJUSTABLE BAR FOLDER

H. TM-8--THE POWER-OPERATED BRAKE

I. TM-9--PARTS OF THE SLIP ROLL

J. TM-10--PARTS OF THE ROTARY MACHINE

V. Unit test

A. The unit test is a one-part test covering the information sheet.

B. Various approaches may be used in testing:

1. Have the students identify safety aspects of wrought iron equipment.

2. Use the test as an assignment.

3. Give an oral test over the information.

C. Include test parts corresponding to any information area added to the unit.

VI. Answers to test

A. Answers are based on total information covered in the unit.

B. For convenience of grading, make corresponding answer sheets for and test parts added.

VII. References

A. *A Suggested Basic Course Outline for General Metal Trades Cluster*. Occupational Curriculum Laboratory, East Texas State University, Commerce, Texas 75428

B. Meyer, Leo A. *Sheet Metal Shop Practice*. American Technical Society, Chicago, Illinois, 1973.

C. Feirer and Tatro. *Metal Tool Metalworking.* McGraw-Hill. New York, 1961.

D. Lascoe, Nelson, and Porter. *Machineshop Operations and Setups.* American Technical Society, Chicago, Illinois, 4th ed., 1973.

UNIT I

SHEET METAL BASICS

INFORMATION SHEET 1--INTRODUCTION TO SHEET METAL

I. Opportunities in sheet metal

A. Classifications

1. Sheet metal fabricator--Produces duct work, and other sheet metal parts in a sheet metal shop.

2. Field installer--Installs the fabricated duct work or parts into a building or system.

3. General sheet metal worker--Performs both the tasks of shop and field workers.

B. Working conditions

1. Outside--Installing gutters, downspouts and other sheet metal products.

2. Inside buildings--Installing ductwork and other fabricated parts into air flow systems.

3. In shop--Fabricating parts for gutters, roofing, siding, storefronts, and other building related products.

C. Training requirements

1. Four years of apprenticeship training.

(NOTE: Most building trades sheet metal workers are members of unions.)

2. Approximately 8000 hours of on-the-job training as a helper.

3. Classroom related instruction.

(NOTE: Includes mathematics, blueprint reading, drafting, and layout work.)

II. Terms and definitions

A. Acid--A liquid that is used as a cleaner or metal before soldering.

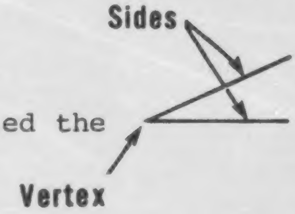
(NOTE: Acids are very harmful to your skin or eyes so use great care when using them.)

B. Alloy--A mixture of two or more metals

C. Aluminum--A soft, light weight metal used for some sheet metals.

D. Angle--The meeting of two straight lines.

(NOTE: The point of intersection is called the vertex.)



E. Apex--The pointed end of a cone.

F. Arc--Any part of the outside edge of a circle.

G. Bar solder--Solder that is molded into a alloy bar of tin and lead.

H. Black iron--An uncoated, hot rolled sheet metal which comes in several thicknesses.

I. Brake--A machine used to bend sheet metal.

(NOTE: A bend in the sheet metal is also a "broke.")

J. Clearance--Space left between parts to allow them to easily be assembled.

K. Duct--A round or rectangular sheet metal pipe.

L. Flux--A chemical used to clean metal during soldering.

M. Flange--A 90° edge or rim formed on a sheet metal part.

N. Gauge--A method of describing the thickness of sheet metal.

(NOTE: See TM-1.)

O. Galvanized--A zinc coating on sheet iron.

P. Miter--The intersection of two round pipes.

Q. Offset--The part that connects two ducts which are not aligned.

R. Pattern--A flat metal piece used as a model to lay out other pieces.

S. Tinning--A coating process of the soldering tip to prepare it for soldering.

T. Transition piece--A sheet metal part designed to join a round duct to a square or rectangular duct.

III. Safety

A. Keep hands and fingers away from moving parts.

B. Operate equipment only after receiving permission from your instructor.

C. Check out each piece of equipment and make all necessary adjustments.

D. Keep all guards on equipment and adjusted properly.

E. Always wear safety glasses.

F. Wear approved shoes made of leather.

G. Remove sharp burrs from sheet metal before working with it on the machines.

H. Do not attempt to work metal that is heavier than the machine's capacity.

I. Do not work more than one sheet at a time on a machine.

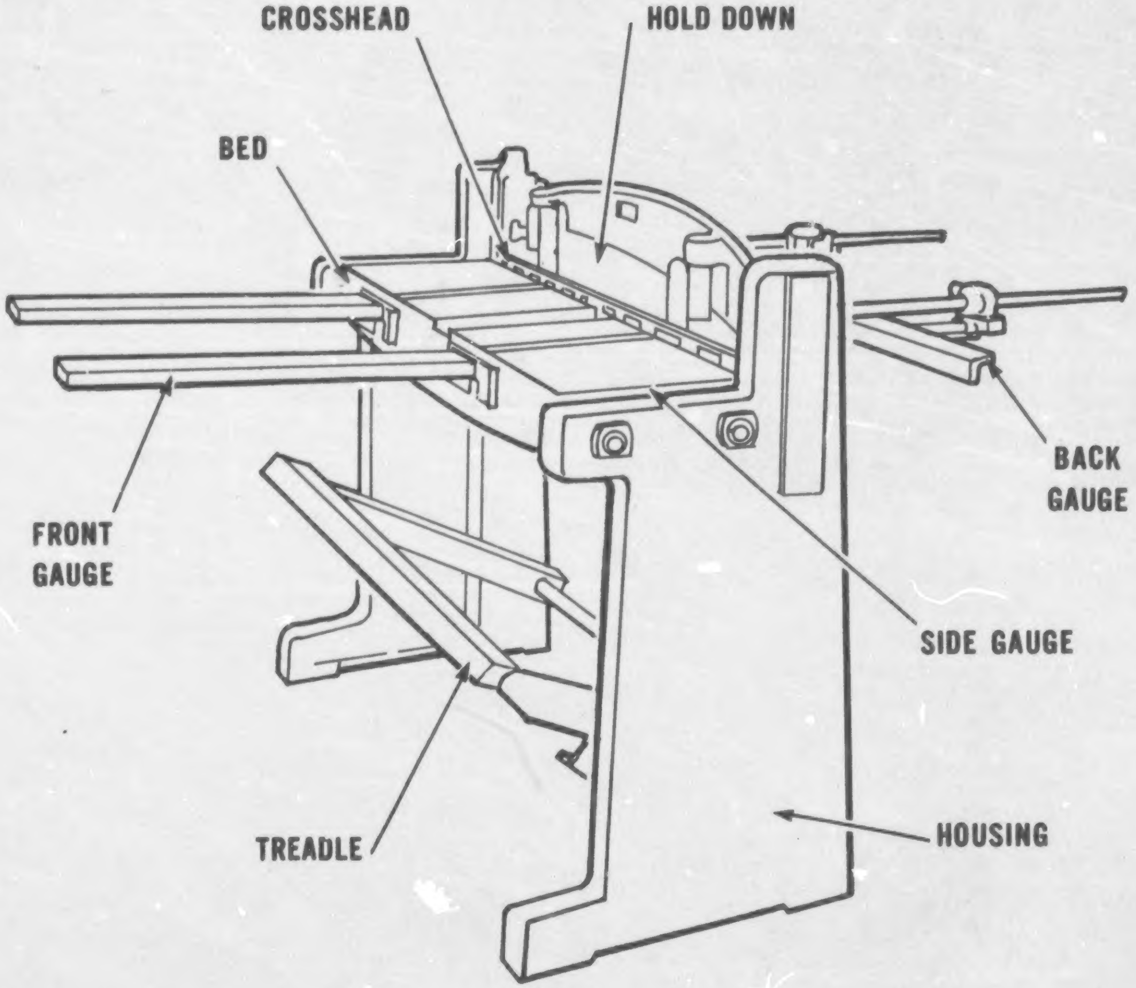
J. Get help when handling large sheets of metal.

K. Wear gloves when handling sheet metal.

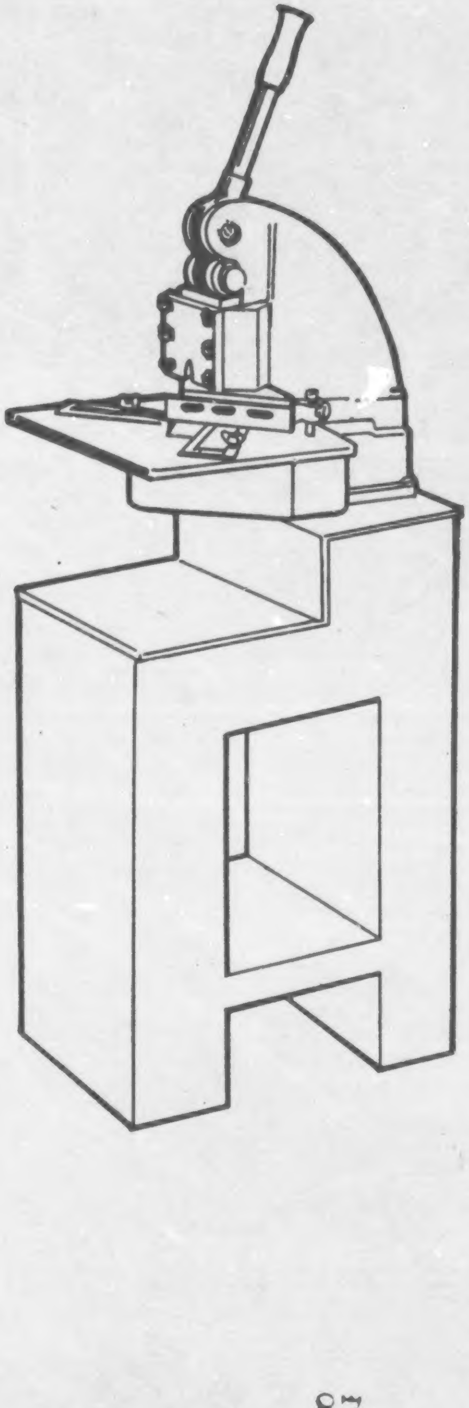
L. Place scraps of metal in a container.

M. Use a machine for the purpose which it was designed only.

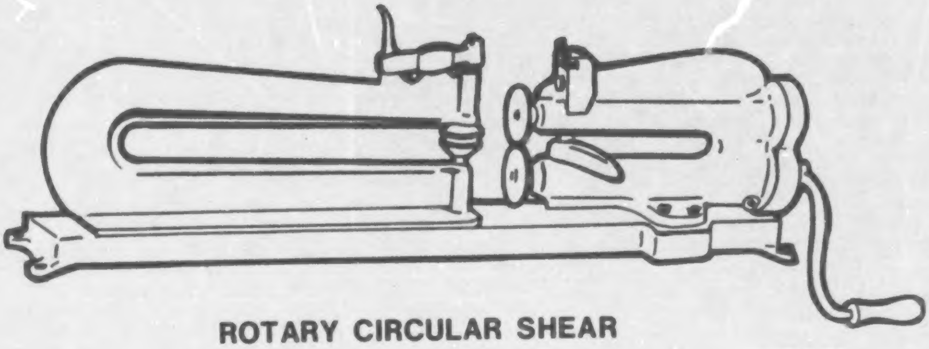
PARTS OF THE SQUARING SHEAR



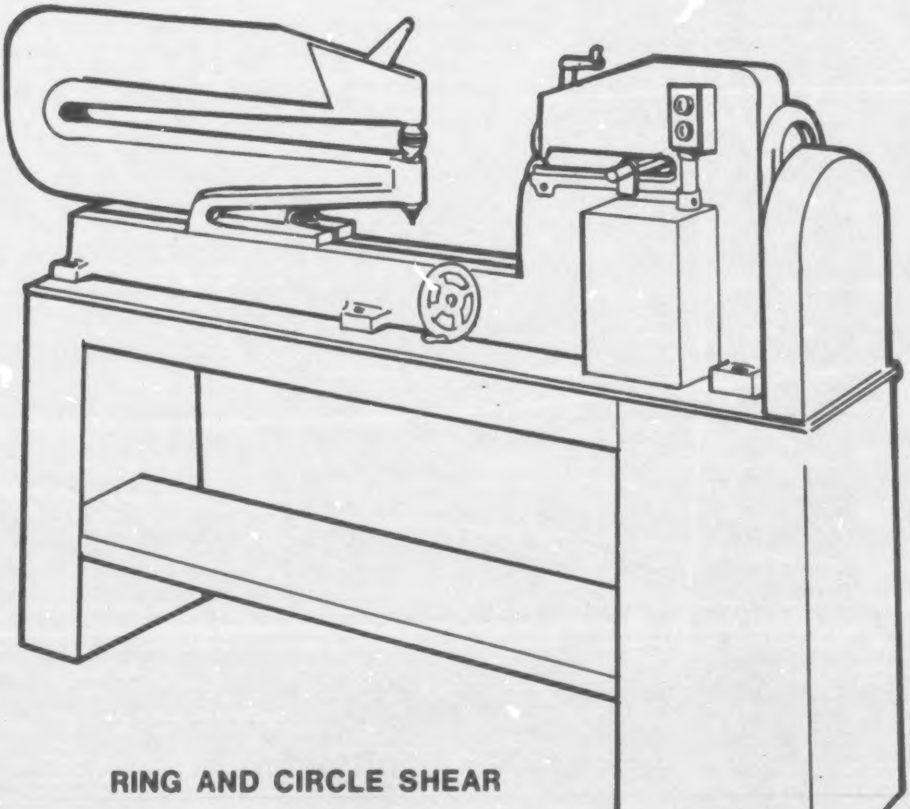
THE NOTCHER



THE ROTARY CIRCLE SHEAR

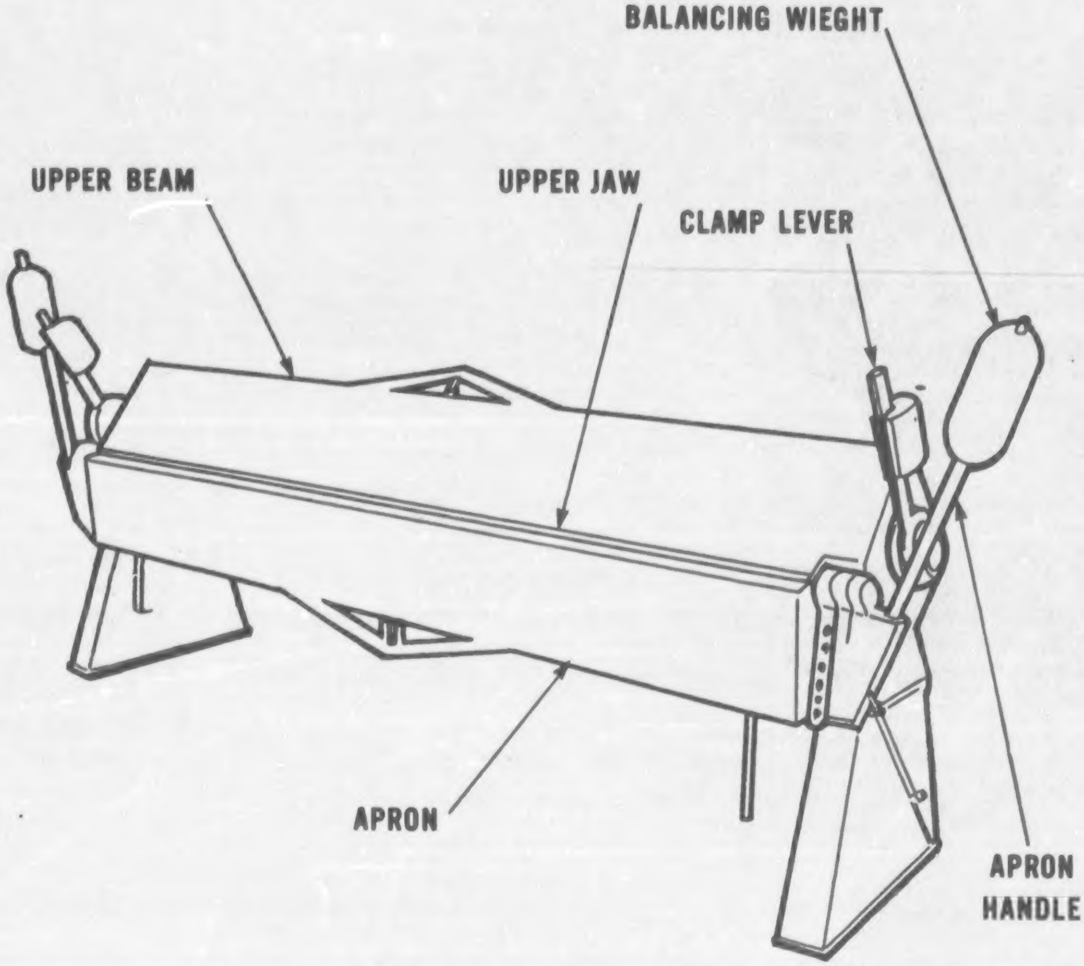


ROTARY CIRCULAR SHEAR

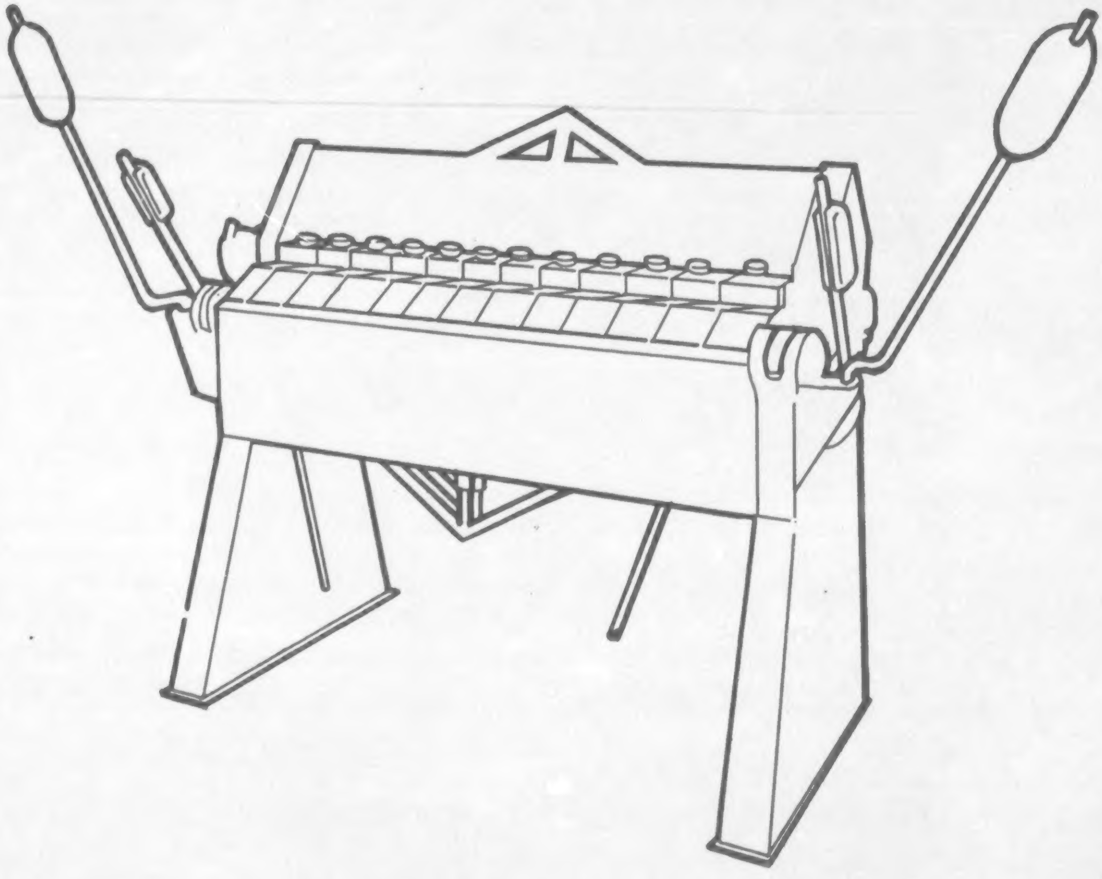


RING AND CIRCLE SHEAR

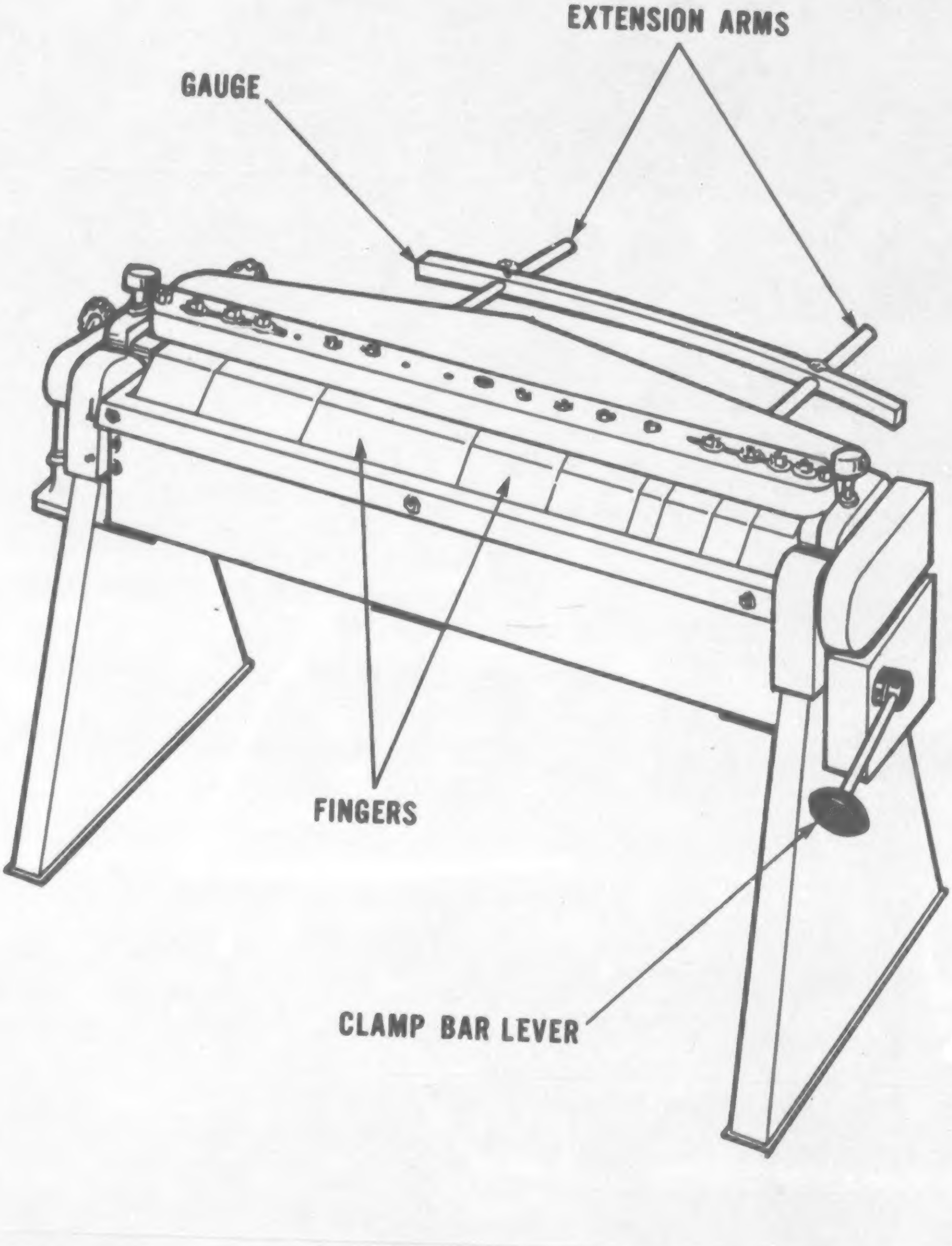
PARTS OF THE BENDING BRAKE



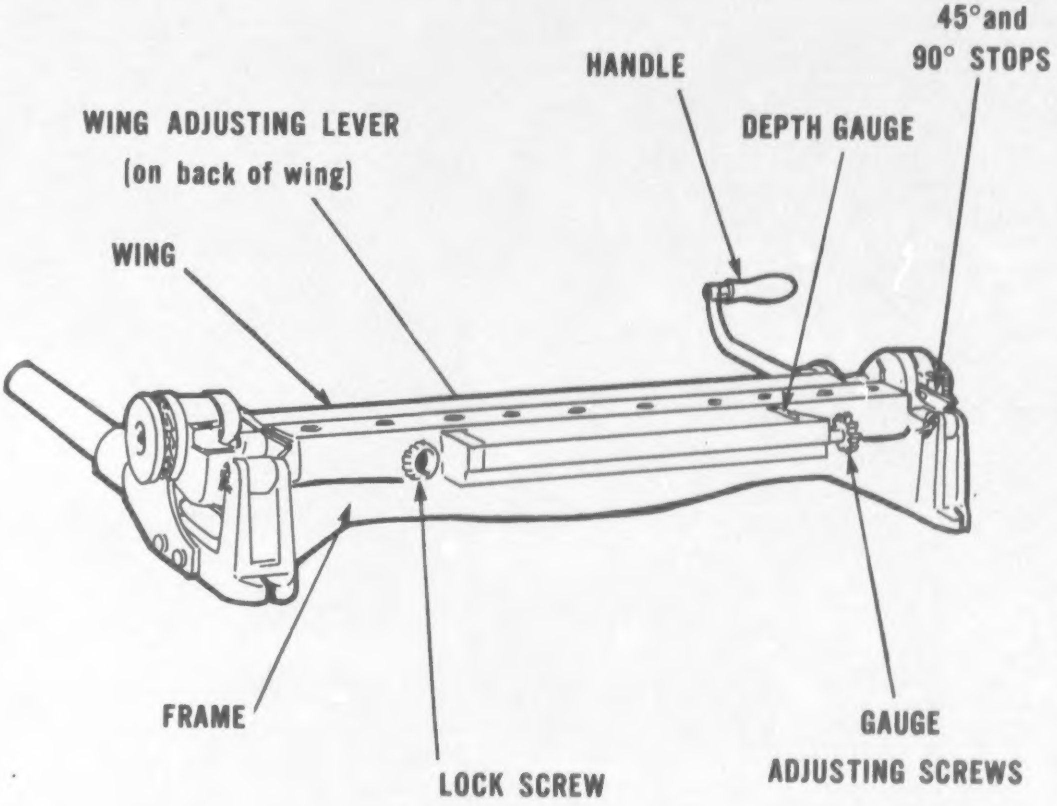
THE BOX BRAKE



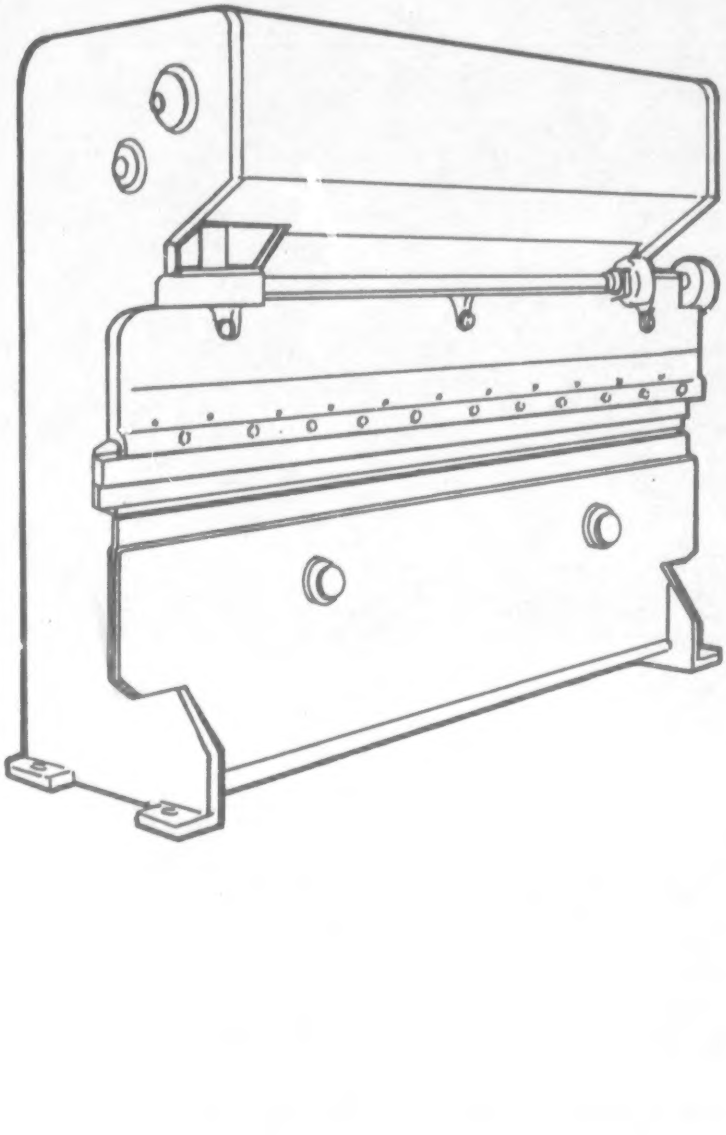
PARTS OF THE FINGER BRAKE



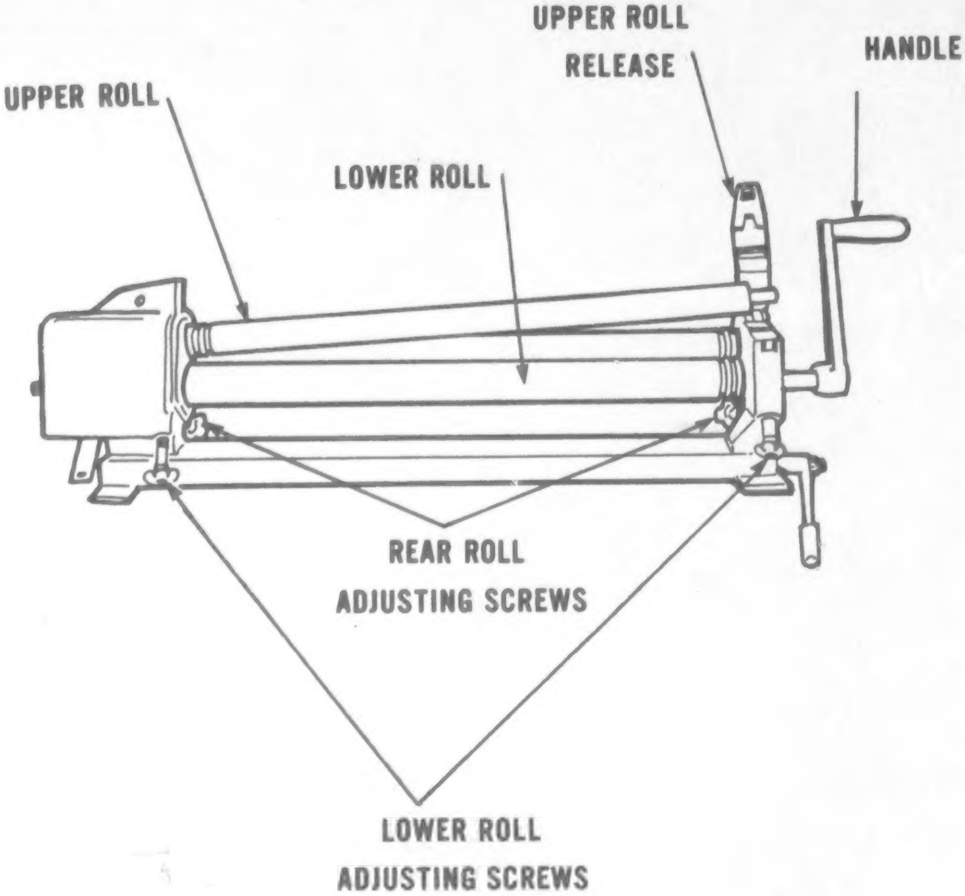
PARTS OF THE ADJUSTABLE BAR FOLDER



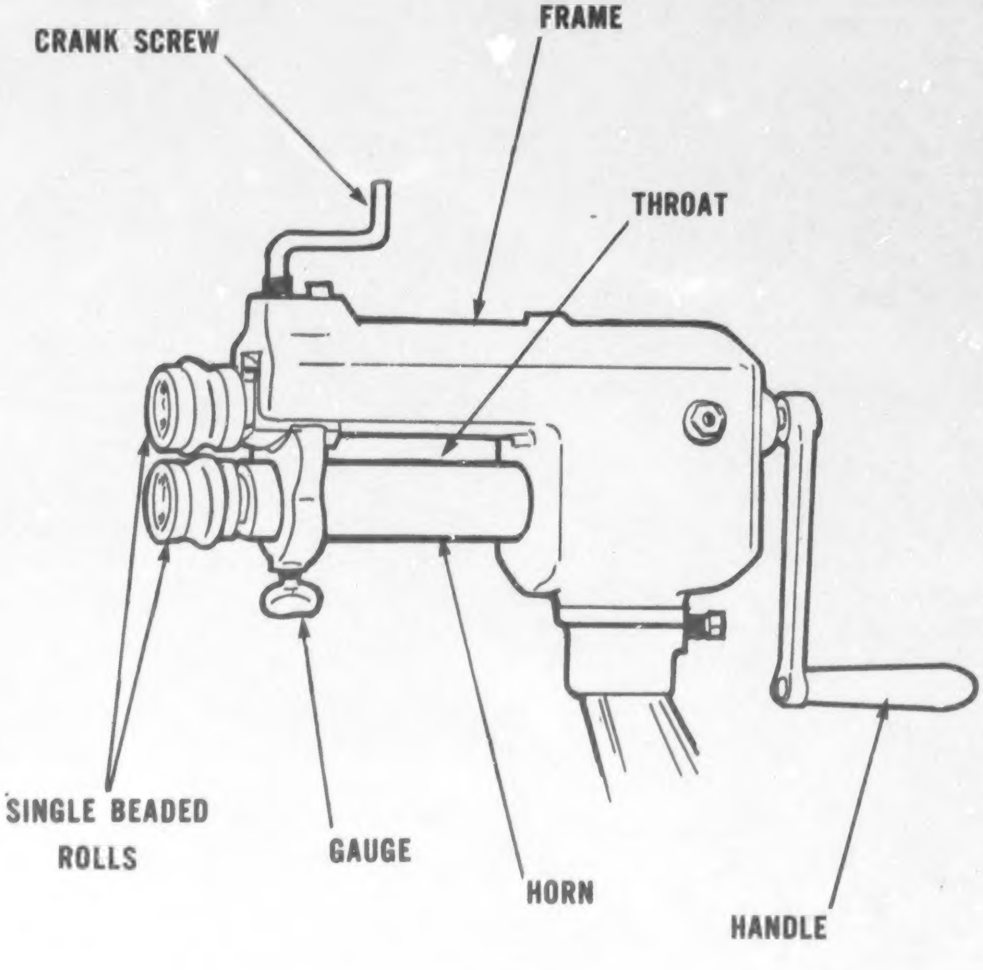
THE POWER - OPERATED BRAKE



PARTS OF THE SLIP ROLL



PARTS OF THE ROTARY MACHINE



UNIT I

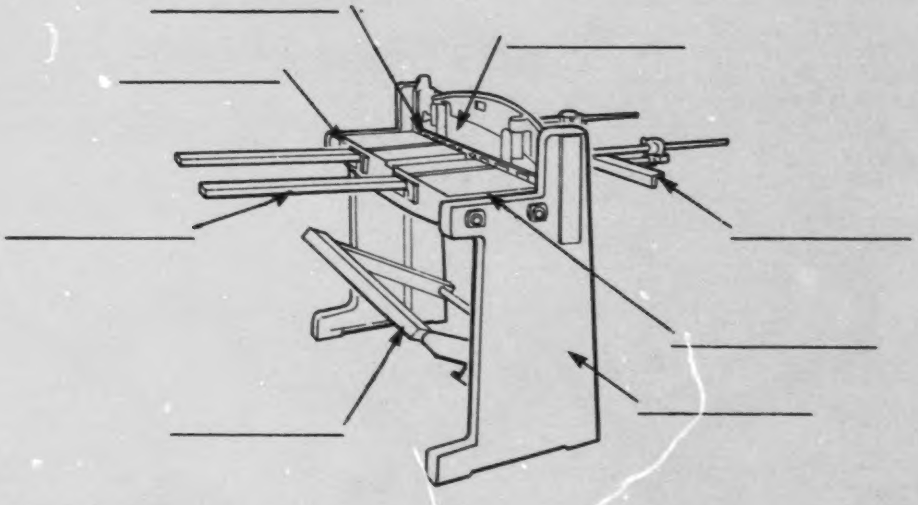
SHEET METAL BASICS

ASSIGNMENT SHEET--IDENTIFY THE PARTS OF SHEET METAL EQUIPMENT

Directions: Identify each of the parts of the equipment pictured below. Write the name of each part in the space provided.

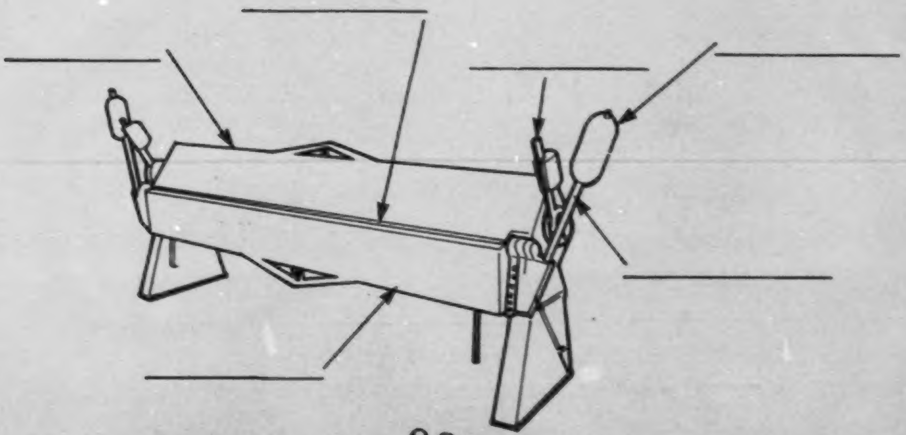
A. Squaring shear

1. Front gauge
2. Bed
3. Crosshead
4. Hold down
5. Treadle
6. Back gauge
7. Housing
8. Side gauge



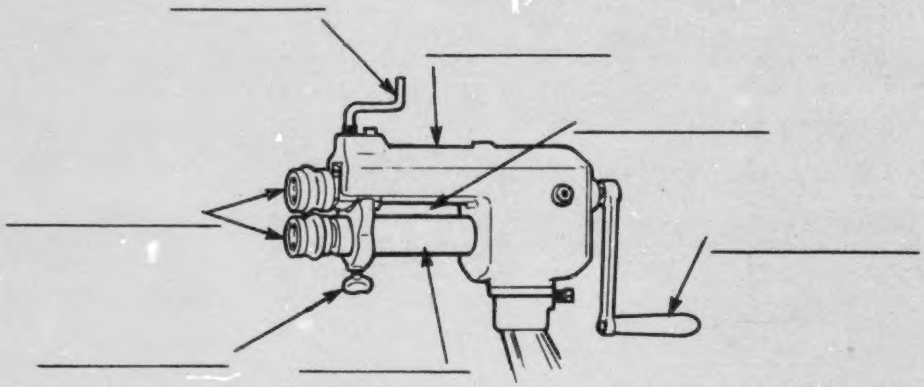
B. Bending brake

1. Upper beam
2. Upper jaw
3. Apron
4. Clamp lever
5. Balance weight
6. Apron handle



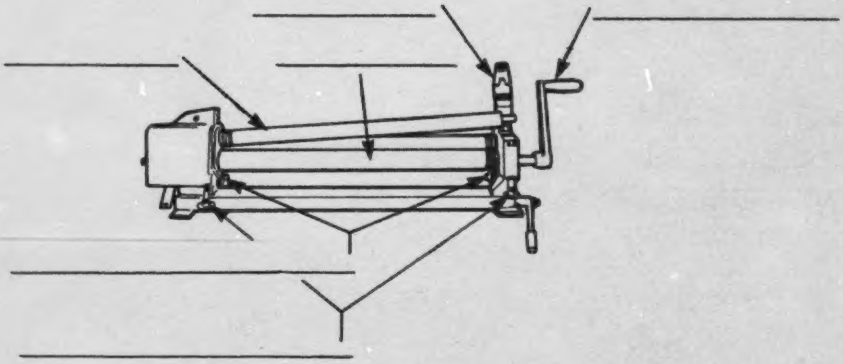
C. Rotary machine

1. Crank screw
2. Frame
3. Throat
4. Single bead rolls
5. Gauge
6. Horn
7. Handle



D. Slip roll

1. Upper roll
2. Upper roll release
3. Lower roll
4. Lower roll adjusting screws
5. Handle
6. Rear roll adjusting screws



UNIT I

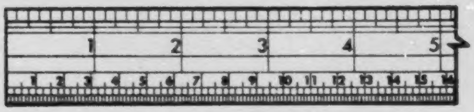
SHEET METAL BASICS

INFORMATION SHEET 2--HANDTOOLS AND EQUIPMENT

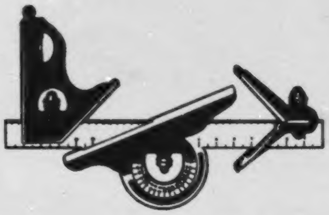
I. Measuring and layout tools.

A. Circumference rule--Used to layout patterns on sheet metal and find the distance around a piece of pipe.

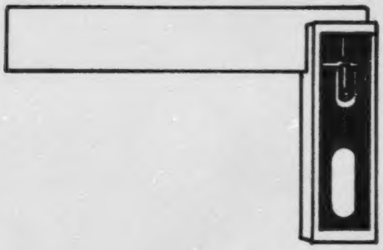
(NOTE: The top row of numbers are inches and the bottom row represents the distance around a pipe in inches.)



B. Combination square--Used in layout to mark right angles or 45° angles.

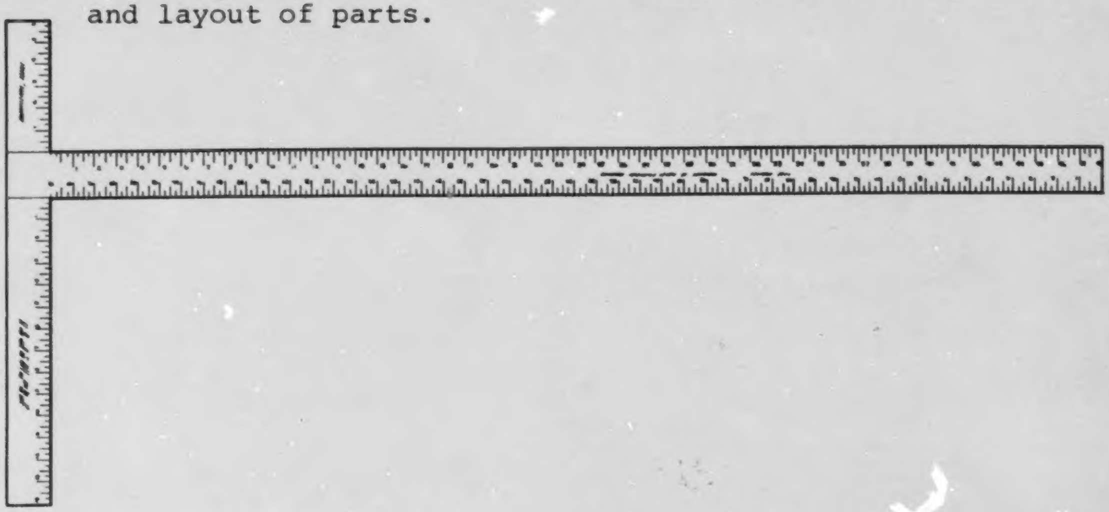


C. Try square--Used in small pattern layout.

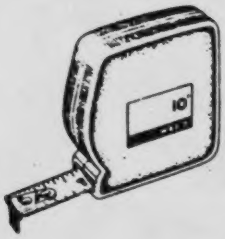


D. Steel rule--Used in layout of small patterns.

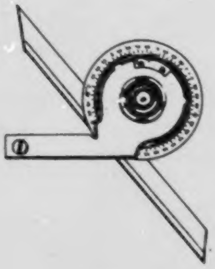
E. Steel square--Used to check assembled parts for squareness and layout of parts.



F. Steel tape--Used to measure longer distances and around curved parts.

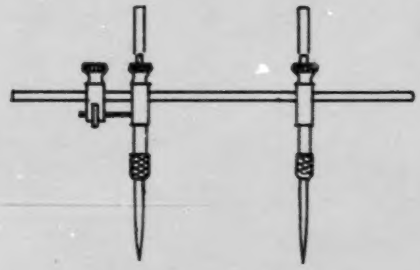


G. Bevel protractor--Used to layout patterns that have angles of specified degrees.

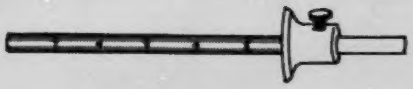


H. Dividers--Used to layout arcs or circles and to divide lines into equal parts.

I. Trammel points--Used as dividers except they are used on larger dimensions.

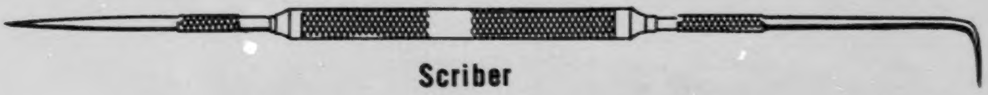


J. Scratch gauge--Used to scribe a line parallel to an edge of the metal.

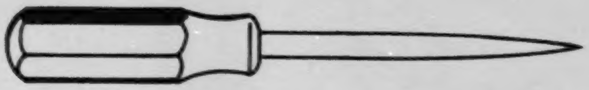


K. Scriber--Used to scribe lines on metal surfaces.

(NOTE: Also called a scratch awl.)

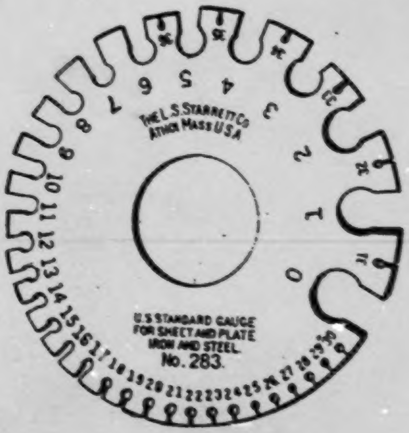


Scriber



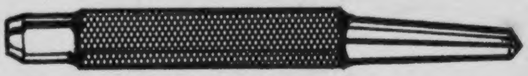
Scatch Awl

L. Wire or sheet metal gauge--Used to determine the thickness of metal before layout.



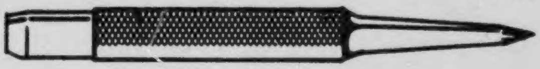
M. Center punch--Used to locate the center point to drill a hole.

(NOTE: The point is ground to 90°.)



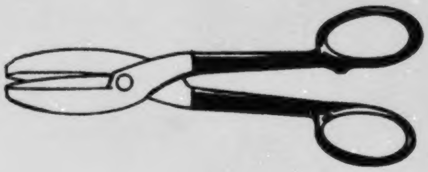
N. Prick punch--Used to locate the center point for drawing arcs and circles.

(NOTE: The point is ground to 30°.)

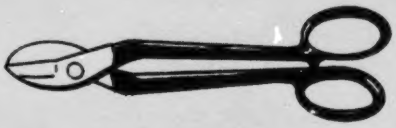


II. Sheet metal cutting tools

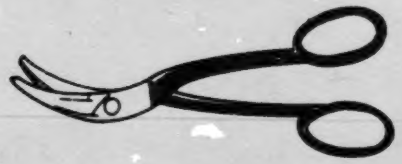
A. Combination snips--Used to make straight cuts on light metal up to 24 gauge.



B. Bulldog snips--Used to make straight cuts on heavier metal up to 16 gauge.



C. Hawk-billed snips--Used to make sharp turns when cutting metal.



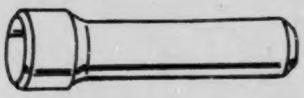
D. Aviation snips--Used to cut out curved shaped patterns on metal up to 20 gauge.

(NOTE: These come in right hand, left hand, and universal styles.)

E. Hand lever punch--Used to punch small holes in light metal.

F. Portable power shears--Used in production work for both straight and circular cutting.

G. Hollow punch--Used to cut holes 1/4" and larger in sheet metal.



III. Sheet metal equipment

A. Cutting equipment

1. Squaring shear--Used to cut and trim sheet metal to size.

a. Foot operated--For light gauge metals.

b. Hydraulic--For heavy gauge metal.

2. Notcher--Used to cut rectangular or square holes or slots in sheet metal.

(NOTE: Some notchers will shear, cope, and notch.)

3. Ring and circle shear--Used to cut large arcs and circles.

B. Forming equipment

1. Bending brake--Used to bend metal to various angles or radius.

2. Box brake--Used to make four-sided boxes and seams on short lengths of sheet metal.

3. Finger brake--Used as the box brake but on light metal for small boxes.

4. Adjustable bar folder--Used to bending edges of metal up to one inch at an angle of 45°, 90°, or closed hem.

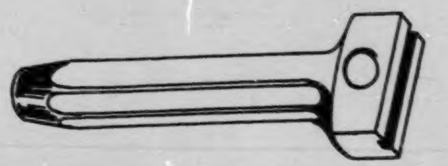
5. Power operated brake--Used in production bending of heavier metal.

6. Slip rolls--Used to shape cylindrical parts.

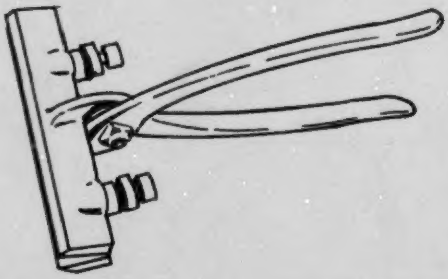
7. Rotary machine--Used to produce a beaded, crimped, wired, or burred edge on sheet metal.

IV. Other sheet metal tools

A. Hand groover--Used to close a seam by hand.

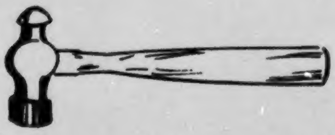


B. Hand seamer--Used to bend small parts or hard to reach places.

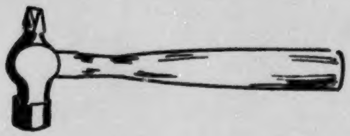


C. Hammers--Used in shaping sheet metal and in combination with other tools.

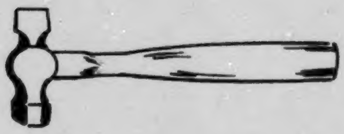
1. Ball peen



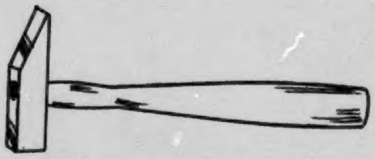
2. Cross peen



3. Straight peen

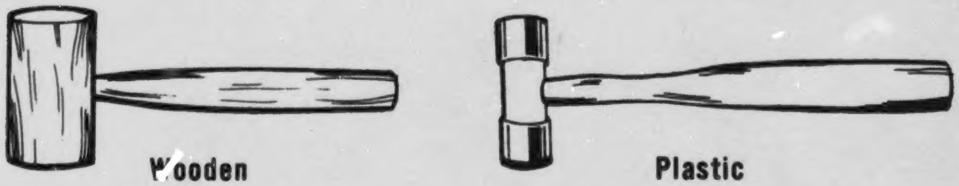


4. Setting

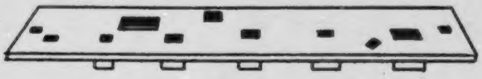


D. Mallets--Used in shaping sheet metal to prevent dents.

(NOTE: Mallets come with wood, rawhide, or plastic heads.)

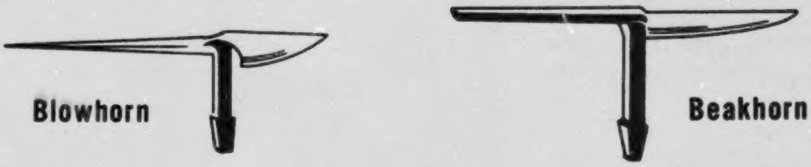


E. Benchplate--Used to hold bench stakes in place while shaping metal.



F. Bench stakes--Used with hammers, mallets, rivet sets, and other sheet metal tools to form and lock seams.

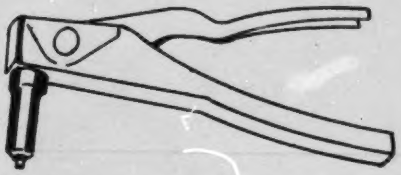
(NOTE: Stakes of all sizes and shapes are available.)



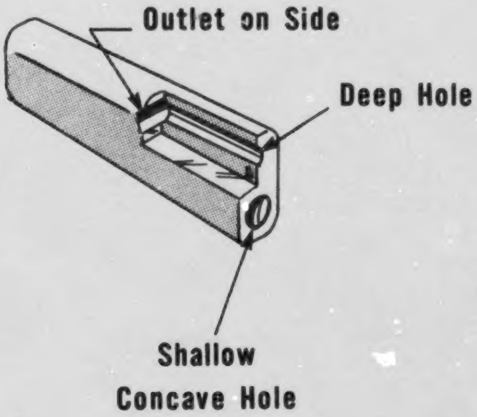
G. Files--Used to smooth rough edges of sheet metal.

(NOTE: Files are available in all shapes and sizes.)

H. "Pop riveter--Used to install "pop" rivets in predrilled holes.



I. Rivet set--Used to draw two sheets of metal together on a rivet and then flatten the rivet.



UNIT I

SHEET METAL

TEST PART 1

1. Point out the opportunities available in the sheet metal industry by selecting the phrase that best completes each sentence below. Write the number of the correct answer in the blank provided.

_____a. The person who produces duct work and other sheet metal parts in a shop is the

(1) manufacturer

(2) sheet metal fabricator

(3) parts worker

_____b. The person who installs fabricated parts in a building is the

(1) building contractor

(2) sheet metal fabricator

(3) field installer

_____c. When working outside, a sheet metal worker would be

(1) roofing buildings

(2) installing gutters and downspouts

(3) fabricating parts

_____d. When working inside buildings, a sheet metal worker would be

(1) installing duct work

(2) laying flooring

(3) installing gutters

_____e. A person beginning in the sheet metal industry should expect

(1) 8,000 hours of on-the-job training

(2) to start as a supervisor

(3) to get little instruction

2. Match the terms associated with sheet metal work to the correct definition. Write the number of each term in the correct blank on the left.

______a. A method of describing the thickness of sheet metal

______b. The meeting of two straight lines

______c. The pointed end of a cone

______d. A chemical used to clean metal during soldering

______e. A zinc coating on sheet iron

______f. The intersection of two round pipes

______g. A sheet metal part designed to join a round duct to a square duct.

______h. A flat metal piece used as a model to layout other pieces

______i. A coating process of the soldering tip to prepare it for soldering

______j. The part that connects two ducts which are not aligned

______k. Space left between parts to allow them to easily fit together

______l. A machine used to bend sheet metal

______m. A mixture of two or more metals

______n. An uncoated, hot rolled sheet metal

______o. A round or rectangular sheet metal pipe

______p. A liquid used as a cleaner before soldering

______q. A light, soft metal used for some sheet metal

______r. A 90° edge or rim formed on a sheet metal part

______s. Solder that is molded into an alloy bar of tin and lead.

______t. Any part of the outside edge of a circle.

1. acid
2. alloy
3. aluminum
4. angle
5. apex
6. arc
7. bar solder
8. black iron
9. brake
10. clearance
11. duct
12. flux
13. flange
14. gauge
15. galvanized
16. miter
17. offset
18. pattern
19. tinning
20. transition piece

3. Select the correct safety rules to follow when working with sheet metal. Write True or False in the blank provided.

_____a. Hands and fingers should be kept away from moving parts.

_____b. Operate equipment any time you feel you are ready to do so.

_____c. Check each piece of equipment and make necessary adjustments before starting the equipment.

_____d. Remove guards that may slow you down.

_____e. Wear safety glasses only when chips are flying.

_____f. Wear shoes made of canvas or cotton cloth.

_____g. Remove sharp burrs from sheet metal before working with it on the machines.

_____h. Most machines will work any gauge metal.

_____i. It saves time to work with several sheets of metal at a time.

_____j. Get help when handling large sheets of metal.

_____k. Wear gloves when handling sheet metal.

_____l. Place scraps of metal in a container when they pile up around a machine.

_____m. Try to find as many uses as possible for each machine.

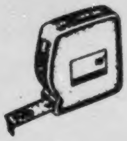
UNIT I

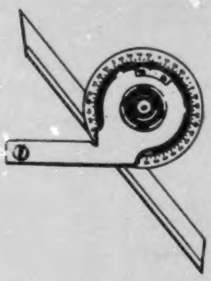
SHEET METAL

TEST PART 2

1. Identify the measuring and layout tools used in sheet metal work. Write each of the names listed below in the blank by the correct illustration.

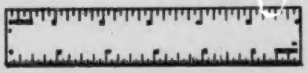
Circumference rule
Combination square
Try square
Scratch gauge
Center punch
Steel rule
Steel square
Steel tape
Scriber
Prick punch
Bevel protractor
Dividers
Trammel points
Wire gauge

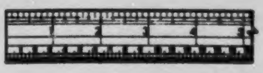




a. ____________________

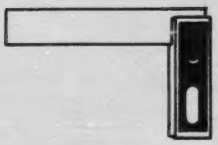
b. ____________________

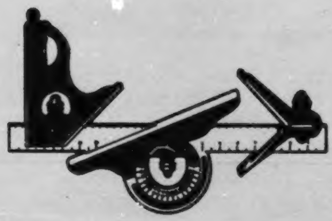




c. ____________________

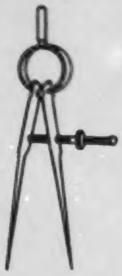
d. ____________________

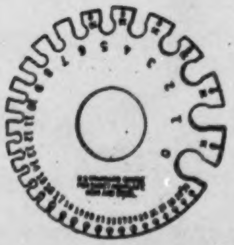




e. ____________________

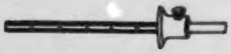
f. ____________________

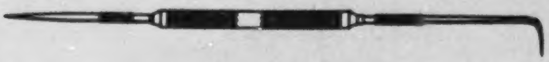




g. ______________________

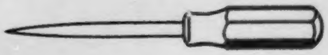
h. ______________________

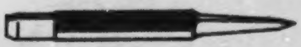




i. ______________________

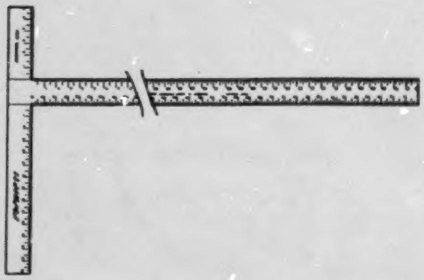
j. ______________________

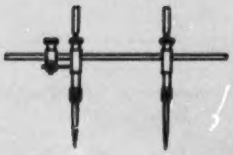




k. ______________________

l. ______________________





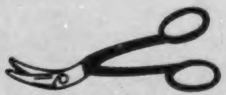
m. ______________________

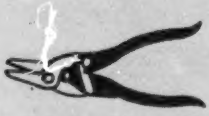
h. ______________________

2. Identify the types of tools used to cut sheet metal. Write the name of each tool listed below in the blank under the correct illustration.

Hollow punch
Hand lever punch
Hawk-billed snips
Combination snips

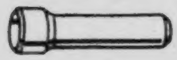
Portable power shears
Aviation snips
Bulldog snips



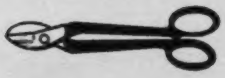


a. ______________________

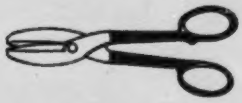
b. ______________________



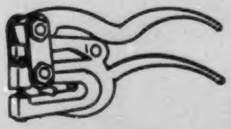
c. ____________________



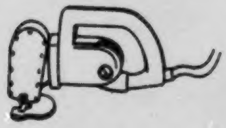
d. ____________________



e. ____________________



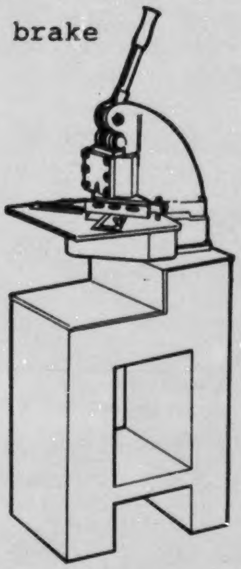
f. ____________________



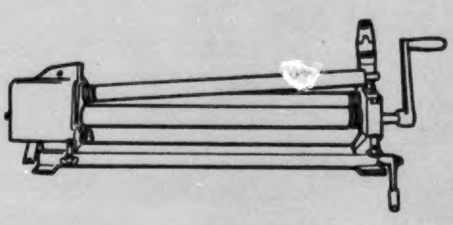
g. ____________________

3. Identify the types of equipment used in sheet metal work. Write the name of each piece equipment listed below in the blank below the correct illustration.

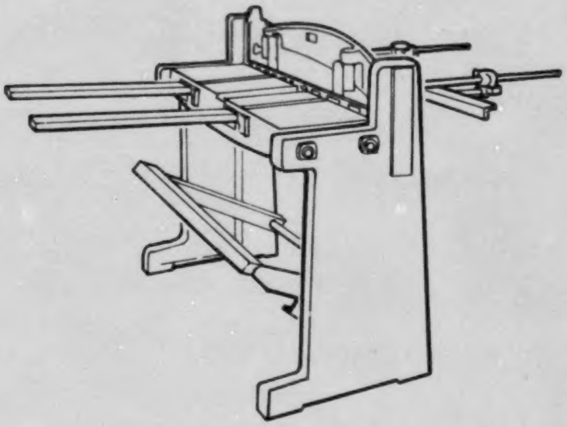
Ring and circle shear	Slip rolls
Squaring shear	Rotary machine
Notcher	Finger brake
Bending brake	Adjustable bar folder

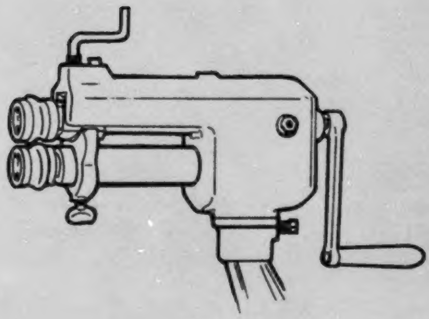


a. ____________________



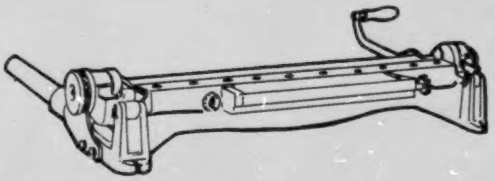
b. ____________________

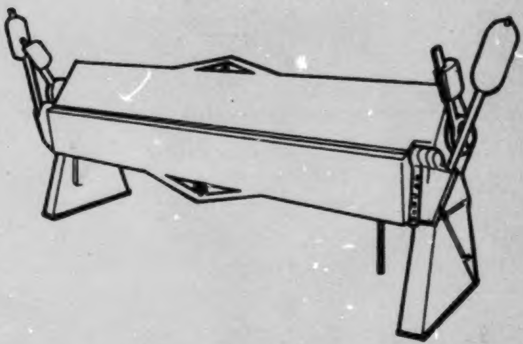




c. ______________________________

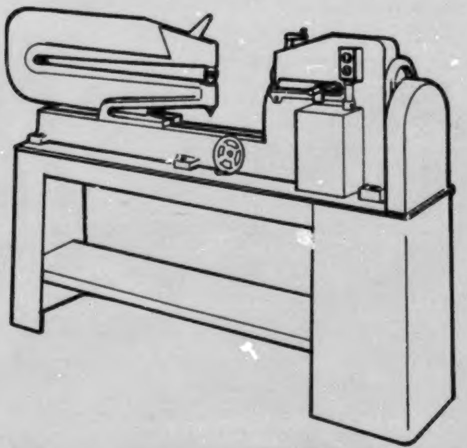
d. ______________________________

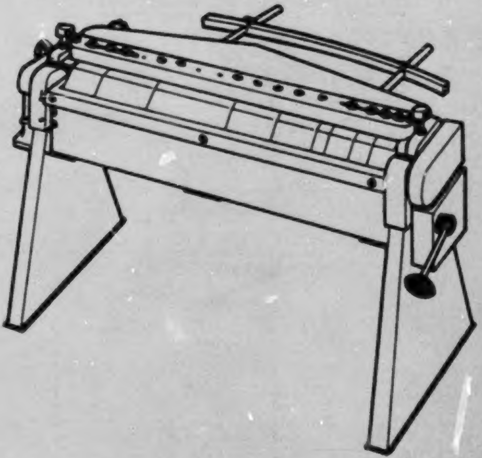




e. ______________________________

f. ______________________________



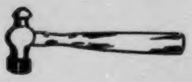


g. ______________________________

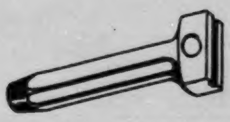
h. ______________________________

4. Identify the other types of tools used in sheet metal work. Write the name of each tool listed below in the correct blank below the illustration.

Rivet set	Pop riveter
Hand seamer	Grooving tool
Bench stake	Mallet
Hammer	Bench plate



a. ____________________



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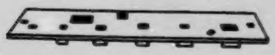

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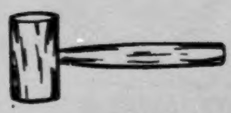

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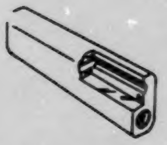

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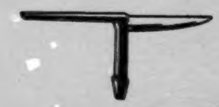
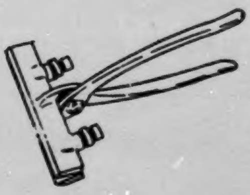


f. ____________________



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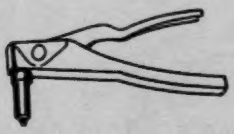


h. ____________________

UNIT I

SHEET METAL BASICS

ANSWERS TO TESTS

Part 1

1. a. 2
   b. 3
   c. 2
   d. 1
   e. 1

2. a. 14
   b. 4
   c. 5
   d. 12
   e. 15
   f. 16
   g. 20
   h. 18
   i. 19
   j. 17
   k. 10
   l. 9
   m. 2
   n. 8
   o. 11
   p. 1
   q. 3
   r. 13
   s. 7
   t. 6

3. a. True
   b. False
   c. True
   d. False
   e. False
   f. False
   g. True
   h. False
   i. False
   j. True
   k. True
   l. False
   m. False

Part 2

1. a. Steel tape
   b. Bevel protractor
   c. Steel rule
   d. Circumference rule
   e. Trysquare
   f. Combination square
   g. Dividers
   h. Sheet metal gauge
   i. Scratch awl
   j. Scriber
   k. Centerpunch
   l. Prick punch
   m. Steel square
   n. Trammel points

2. a. Hawk-billed snips
   b. Aviation snips
   c. Hollow punch
   d. Bulldog snips
   e. Combination snips
   f. Hand lever punch
   g. Portable power shears

3. a. Notcher
   b. Slip rolls
   c. Squaring shear
   d. Rotary machine
   e. Adjustable bar folder
   f. Bending brake
   g. Ring and circle shear
   h. Finger brake

4. a. Hammer
   b. Grooving tool
   c. Bench plate
   d. Mallet
   e. Rivet set
   f. Bench stake
   g. Hand seamer
   h. Pop riveter

UNIT II

SHEET METAL FABRICATION

UNIT OBJECTIVE

Upon completion of this unit, the student will be able to identify the different types of metals used for sheet metal and the methods of assembling sheet metal parts. The student will also be able to select the correct drafting equipment, types of lines, and geometric figures used in pattern developments. This knowledge will be evidenced through demonstration and by satisfactorily completing the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Point out the types of sheet metals used for sheet metal fabrication.
2. Identify the types of seams used in sheet metal assembly.
3. Select the methods of assembling sheet metal.
4. Identify the types of drafting equipment used in pattern development.
5. Draw each of the types of lines used in pattern development.
6. Identify each of the types of angles used in pattern development.
7. Identify each of the types of plane surfaces used in pattern development.
8. Identify the solid geometric figures used in pattern development.
9. Point out the methods of pattern development.
10. Identify each of the types of joints used in sheet metal assembly.
11. Figure circumference.
12. Measure with a protractor.
13. Develop a pyramid pattern.
14. Layout a flat pattern of a funnel.
15. Demonstrate the ability to:
    a. Form a Pittsburg lock seam
    b. Solder a joint
    c. Rivet a joint
    d. Layout and assemble a box

UNIT II

SHEET METAL FABRICATION

SUGGESTED TEACHING ACTIVITIES

I. Objective sheet

   A. Discuss the unit objective with the students.

   B. Discuss each specific objective with the students.

   C. Have the students complete the objectives in the most logical sequence for the shop organization.

   D. Add any objectives that are necessary.

II. Information and assignment sheets

   A. INFORMATION SHEET 1--SHEET METAL ASSEMBLY

      1. Discuss the characteristics of the different types of sheet metals (Transparency 1).

      2. Explain the use of the various types of seams used in sheet metal fabrication.

      3. Point out the types of patterns used for sheet metal assembly (Transparency 3).

      4. Explain the purpose of soldering sheet metal joints (Transparency 2).

   B. INFORMATION SHEET 2--PATTERN DEVELOPMENT

      1. Explain the use of each of the pieces of drafting equipment.

      2. Explain the types of lines used in pattern development.

      3. Discuss how each angle is used in pattern development.

      4. Discuss the relation of triangles to pattern development.

      5. Discuss the use of solid figures in sheet metal layout.

      6. Compare the methods of pattern development.

      7. Use the following assignment sheets to reinforce this area of information:

         a. ASSIGNMENT SHEET 1--FIGURE CIRCUMFERENCE

         b. ASSIGNMENT SHEET 2--MEASURE WITH A PROTRACTOR

         c. ASSIGNMENT SHEET 3--DEVELOP A PYRAMID PATTERN

         d. ASSIGNMENT SHEET 4--LAY OUT A FLAT PATTERN OF A FUNNEL

III. Transparency Masters

(NOTE: Transparencies are included in the student manual as information sheets.)

- A. TM-1--THICKNESS AND WEIGHT PER SQUARE FOOT OF SHEET METAL GAUGES
- B. TM-2--TOOLS AND SUPPLIES FOR SOLDERING
- C. TM-3--PARTS OF A SPOT WELDER
- D. TM-4--PARTS OF A CIRCLE
- E. TM-5--TYPES OF JOINTS
- F. TM-6--COMMON SHEET METAL SHAPES

IV. Job Sheets

- A. JOB SHEET 1--FORM A PITTSBURG LOCK SEAM
  - 1. Provide metal strips for student practice.
  - 2. Demonstrate the procedures
- B. JOB SHEET 2--SOLDER A JOINT
  - 1. Discuss the safety factors relating to soldering.
  - 2. Provide necessary soldering equipment.
  - 3. Demonstrate the soldering process.
- C. JOB SHEET 3--RIVET A JOINT
  - 1. Provide students with strips of metal for riveting.
  - 2. Demonstrate the procedures.

V. Unit test

- A. The unit test is a one-part test covering the information sheet.
- B. Various approaches may be used in testing.
  - 1. Have student identify safety aspects of wrought iron equipment.
  - 2. Use the test as an assignment.
  - 3. Give an oral test over the information.

VI. Answers to test

- A. Answers are based on total information covered in the unit.
- B. For convenience in grading, make corresponding answer sheets for any test parts added.

VII. Reference

A Suggested Basic Course Outline for General Metal Trades Cluster. Occupational Curriculum Laboratory, East Texas State University, Commerce, Texas 75428

UNIT II

SHEET METAL FABRICATION

INFORMATION SHEET 1--SHEET METAL ASSEMBLY

I. Types of sheet metals

   A. Sheet steel--A bluish-black surfaced sheet metal.

      (NOTE: Sheet steel comes in a variety of gauges. See Transparency 1)

   B. Cold roll steel--A high quality sheet steel which is silver grey in color.

   C. Copper sheet--A reddish-brown sheet metal used in production of radiators, electrical parts, and roofing parts.

   D. Coated metals--Sheet metal base with a coating on the surface.

      1. Galvanized--Used for gutters, downspouts, and trash cans.

      2. Tin plate--A sheet metal with a thin tin coating which is used in food containers and kitchen utensils.

   E. Alloy metal--The combination of two or more metals.

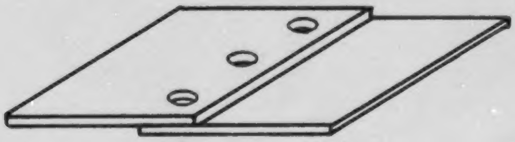
      1. Aluminum alloy--Used because of its light weight.

      2. Stainless steel--Used in restaurants and cafeterias because of its resistance to corrosion and strength.

      3. Brass--An alloy of copper and zinc used in cameras, missiles, and electronic parts.

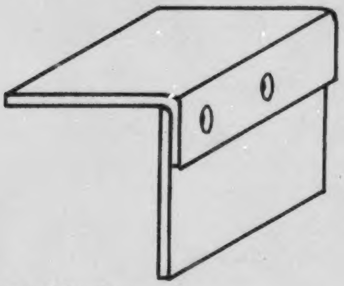
II. Types of sheet metal seams

   A. Lap seam--Must be secured by solder, spot welding, or machine screws

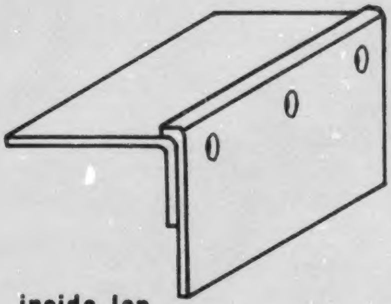


lap seam

B. Riveted corner seam--A corner lap joint held with rivets.

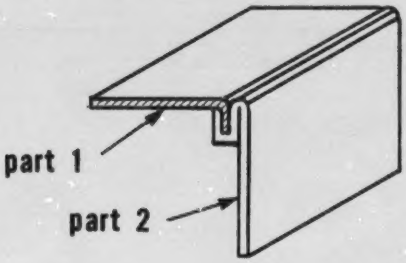


outside lap

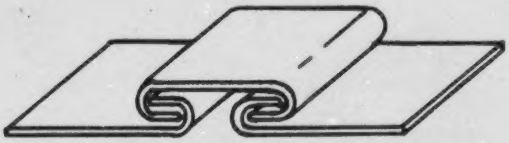


inside lap

C. Pocket solder lock seam--Provides a smooth corner seam.

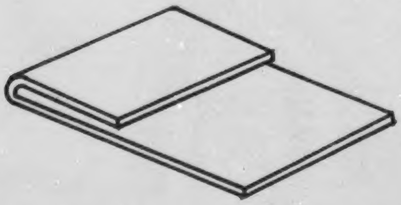


D. Cap seam--Used to join long flat sheets.

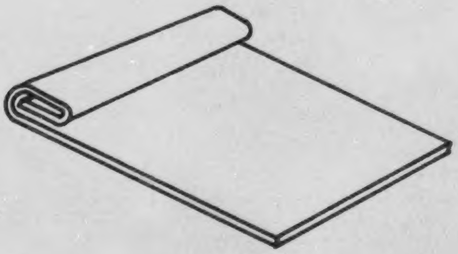


cap seam

E. Hem--Used to provide a smooth edge without sharp edges or to provide stiffness in the edge.

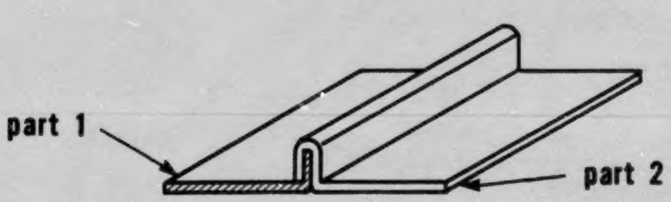


single hem

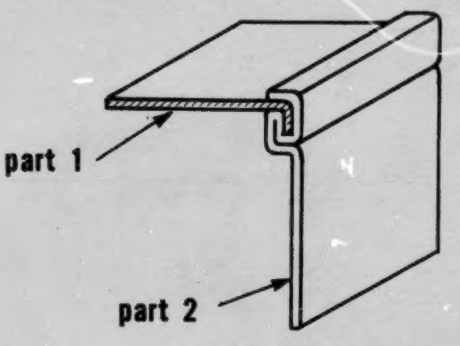


double hem

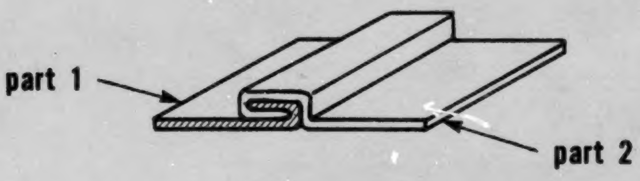
F. Standing seam--Provides support for the sheet metal.



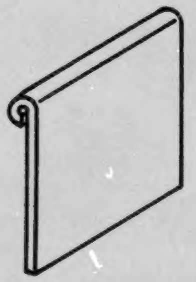
G. Pittsburg corner lock seam--Used in airconditioning ductwork.



H. Grooved lock seam--Used to join sheets or seams on pipes.



I. Wire edge--The edge of the sheet wrapped around the wire to provide strength.



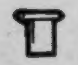
wire edge

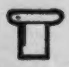
III. Types of sheet metal fasteners.

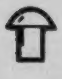
A. Rivets--Placed through predrilled holes in place of bolts to fasten joint.

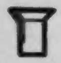
1. Tinners rivets
2. Flathead rivets
3. Roundhead rivets
4. Countersunk rivets
5. "Pop" rivets

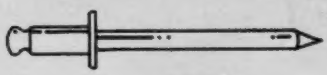
(NOTE: The most popular of rivets because of speed of installation. They come in steel and aluminum and are installed with a "pop" riveter.)


thinner


flathead


roundhead


countersunk


'pop'

B. Soldering--Applied to the joint in a molten form to fasten the two pieces together.

1. Bar solder
2. Solid wire
3. Acid core
4. Rosin core

C. Spot welding--Uses an electric arc provided by the spot welder to fasten the two pieces of metal.

D. Sheet metal screws--Used when spot welding is not available or on thicker metal.

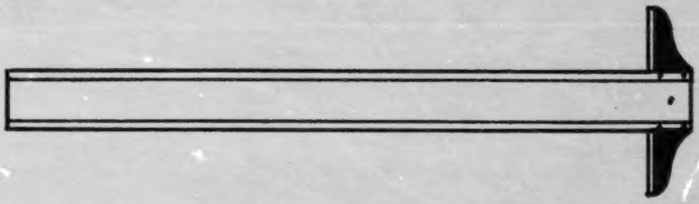
UNIT II

SHEET METAL FABRICATION

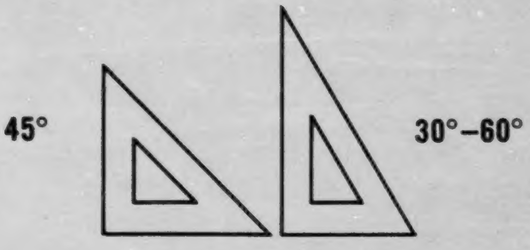
INFORMATION SHEET 2--PATTERN DEVELOPMENT

I. Drafting equipment

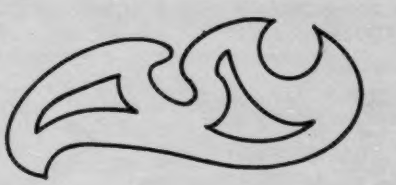
A. T-square



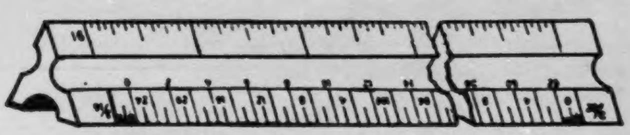
B. Triangles



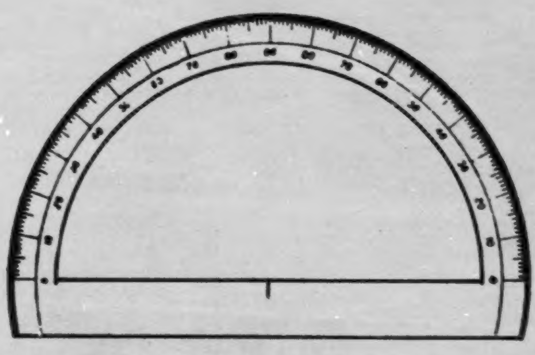
C. French curve



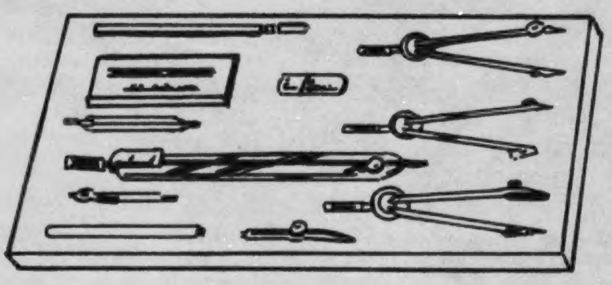
D. Scale



E. Protractor



F. Drawing instruments



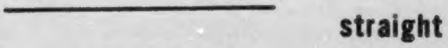
G. Drafting board--The board is usually a 18" x 24" surface which provides a guide for the T-square and a working surface for the drafting paper.

H. Pencils--Pencils are rated from H to 9H and a 2H is most commonly used in drafting.

(NOTE: H indicates the hardness of the pencil lead with 9 H being the harder.)

II. Types of lines used in pattern development

A. Straight line--A line in the same direction that is the shortest distance between two points.



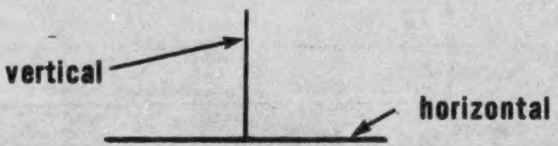
B. Curved line--A line that is always changing directions.

C. Parallel lines--A line having the same direction but never crossing.

(NOTE: They are equal distance from each other at all points.)

D. Horizontal line--A line parallel to the horizon.

E. Vertical line--A line at a right angle to the horizon.



UNIT II

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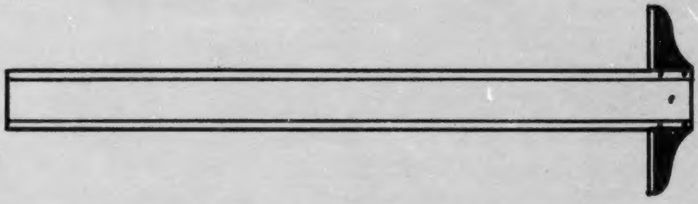
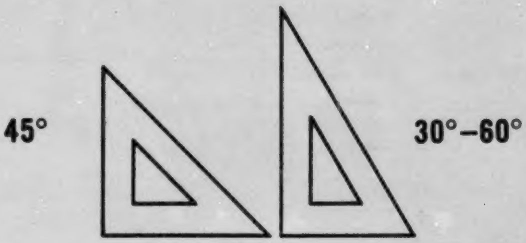
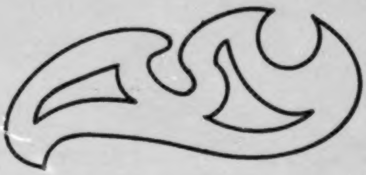


B. Triangles



C. French curve



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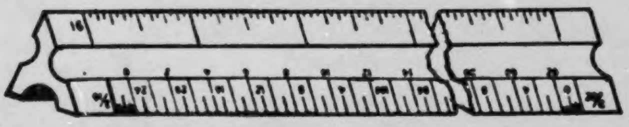
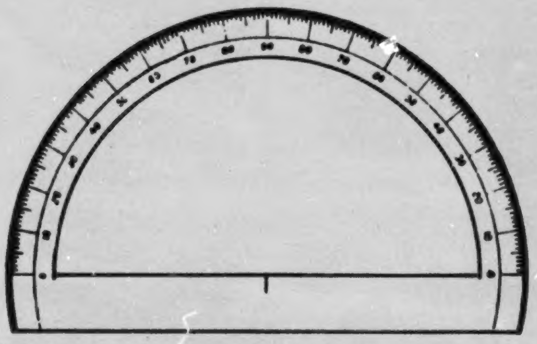
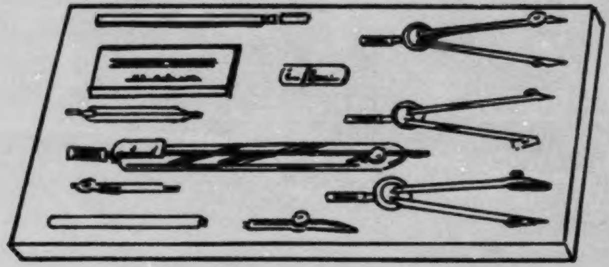


E. Protractor



F. Drawing instruments



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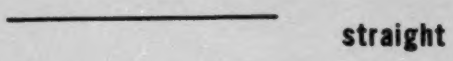

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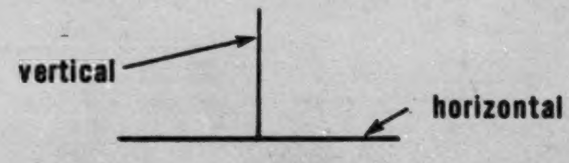
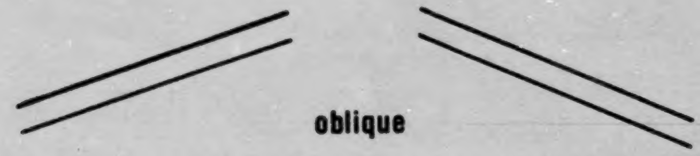
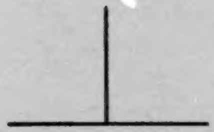


F. Oblique line--A line drawn at any angle between the vertical and horizontal position.



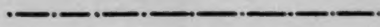
oblique

G. Perpendicular line--A line that is at a right angle to another line.



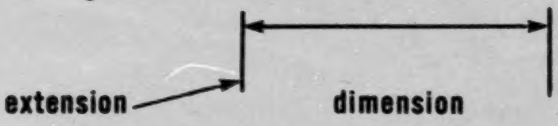
perpendicular

H. Center line--A line used to show the center of a circle or round object.



center line

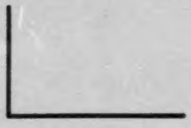
I. Dimension line--A line used with figures to show the size of an object.



J. Extension line--A line used to extend the object so that it may be dimensioned.

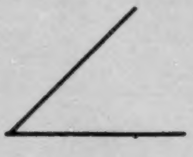
III. Angles used in pattern development

A. Right angle--A 90° angle formed by the intersection of two perpendicular lines.



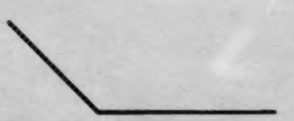
90° right angle

B. Acute angle--An angle that is less than 90° or the right angle.



acute angle

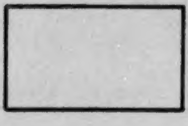
C. Obtuse angle--An angle greater than 90° or the right angle.



obtuse angle

IV. Plane surfaces used in pattern development.

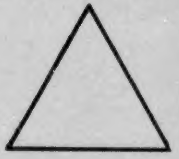
A. Rectangle--A four-sided figure which has all right angles.



rectangle

B. Triangle--A figure bounded by three straight lines.

1. Equilateral triangle--All angles are equal

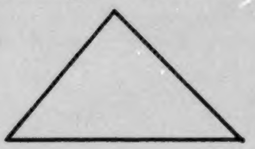


equilateral

2. Right angle triangle--One angle is a right angle.

right

3. Acute angle triangle--All angles are acute.

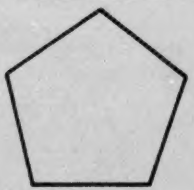


acute

4. Obtuse-angle triangle--One angle is an obtuse angle.

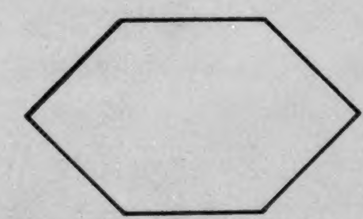
obtuse

C. Pentagon--A figure with five equal sides.



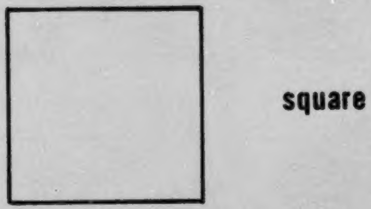
pentagon

D. Hexagon--A figure with six equal sides.

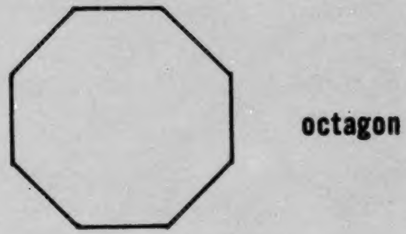


hexagon

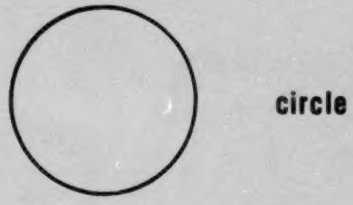
E. Square--A figure with four equal sides and all angles are right triangles.



F. Octagon--A figure with eight equal sides.



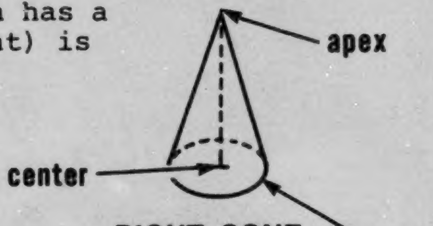
G. Circle--A figure with a curved side which has all parts equal distance from the center.



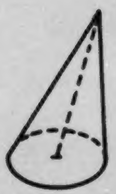
H. Ellipse--A figure similar to a circle but is not round.

V. Solid geometric figures used in pattern development.

A. Right cone--A solid figure which has a circular base and the apex (point) is in the center of the base.



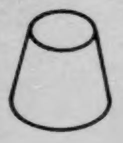
RIGHT CONE



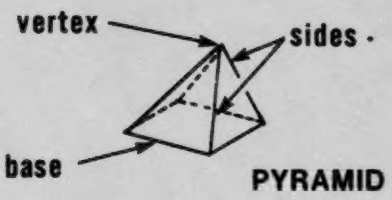
OBLIQUE CONE

B. Oblique cone--A figure which has the apex (point) off of center of the base.

C. Frustrum--A figure that is a portion of a cone.



FRUSTRUM

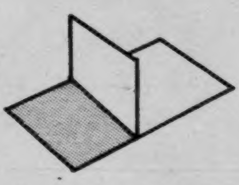


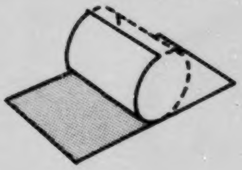
PYRAMID

Pyramid--A figure with a four-sided base and triangular sides that have the same vertex.

VI. Methods of pattern development.

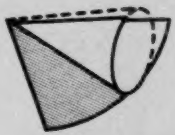
A. Straight-line (or angular)--Used for pattern layout of boxes, containers, and trays.

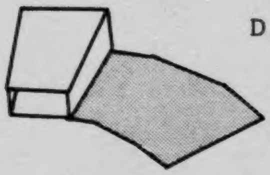




B. Cylindrical (or parallel line)--Used for pattern layout of bands, tubes, pipes, and scoops.

C. Radial-line (or cone)--Used for pattern layout of cone-shaped objects such as funnels, buckets, and tapered round containers.





D. Transition (or triangulation)--Used for pattern development of objects with sides that slant at different angles.

VII. Types of joints

A. Tees--Pieces of metal assembled to look like the letter T.

B. Wyes--Pieces of metal assembled to look like the letter Y.

C. Elbows--A piece of metal which has been bent at an angle of 90° or less.

D. Flanges--A rim or collar attached to pipes and duct work so that they may be bolted together.

E. Ogees--A piece of metal with an S shape.

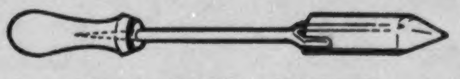
THICKNESS AND WEIGHT OF SHEET METALS

(PER SQ. FT.)

GALVANIZED AND BLACK IRON

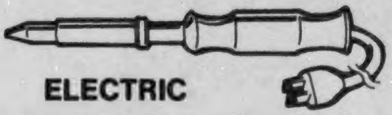
STANDARD GAGE	APPROXIMATE THICKNESS GALVANIZED (inches)	LBs/SQ FT GALVANIZED	LBs/SQ FT BLACK IRON
7	0.1793	---	7.500
8	0.1644	---	6.875
9	0.1494	---	6.250
10	0.1345	5.7812	5.625
11	0.1196	5.1562	5.000
12	0.1046	4.5312	4.375
13	0.0897	3.9062	3.750
14	0.0747	3.2812	3.125
15	0.0673	2.9687	2.812
16	0.0598	2.6562	2.500
17	0.0538	2.4062	2.250
18	0.0478	2.1562	2.000
19	0.0418	1.9062	1.750
20	0.0359	1.6562	1.500
21	0.0329	1.5312	1.375
22	0.0299	1.4062	1.250
23	0.0269	1.2812	1.125
24	0.0239	1.1562	1.000
25	0.0209	1.0312	0.875
26	0.0179	0.9062	0.750
27	0.0164	0.8437	0.688
28	0.0149	0.7812	0.625
29	0.0135	0.7187	0.563
30	0.0120	0.6562	0.500

TOOLS AND SUPPLIES USED FOR SOLDERING

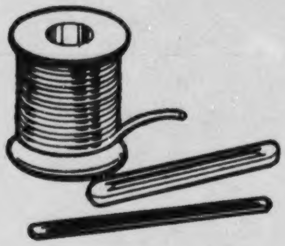


SOLDERING COPPER

SOLDERING GUN



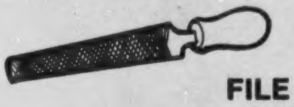
ELECTRIC SOLDERING COPPER



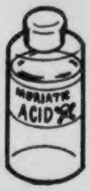
WIRE AND BAR SOLDER

STEEL WOOL

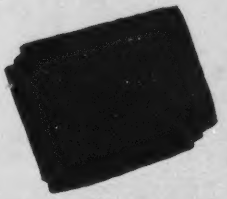
WIRE BRUSH



FILE

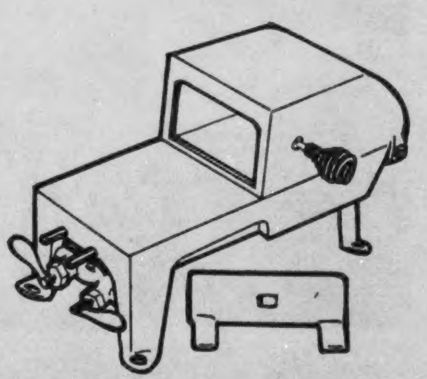


MURIATIC ACID



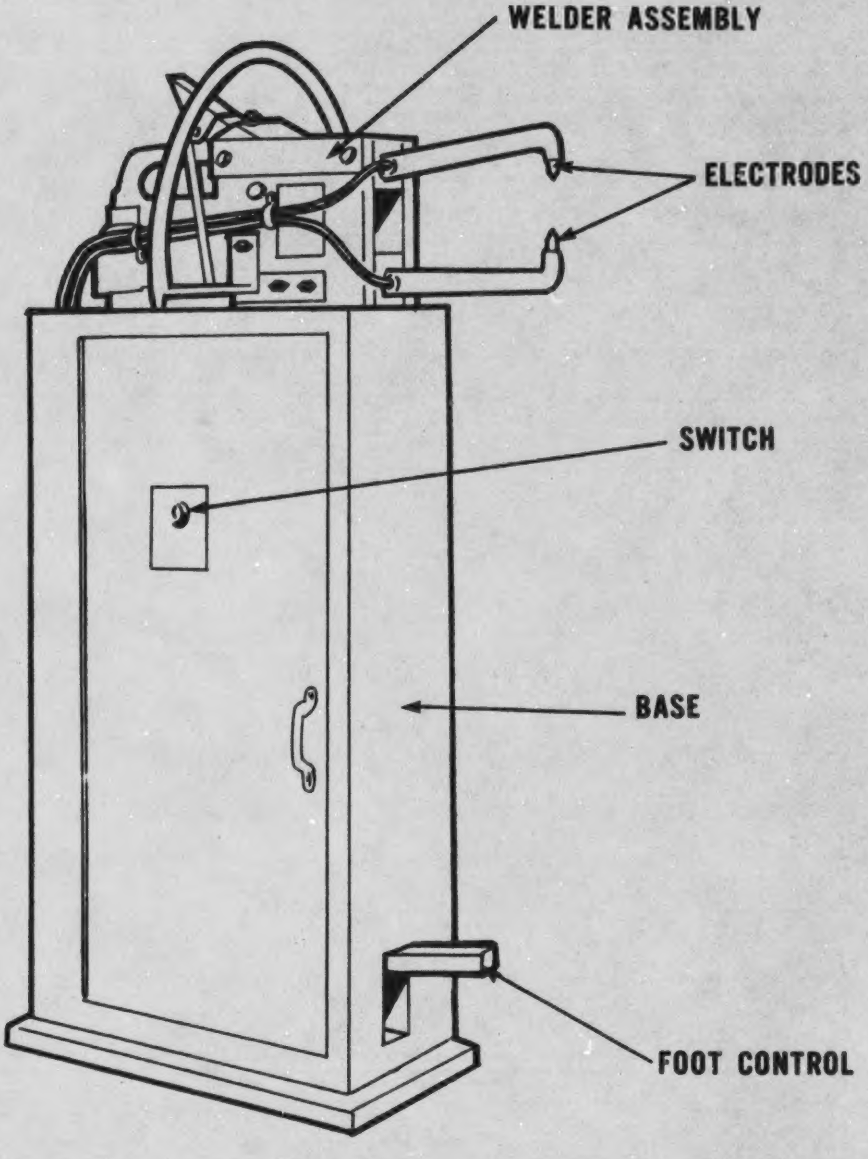
EMERY CLOTH

BLOWTORCH

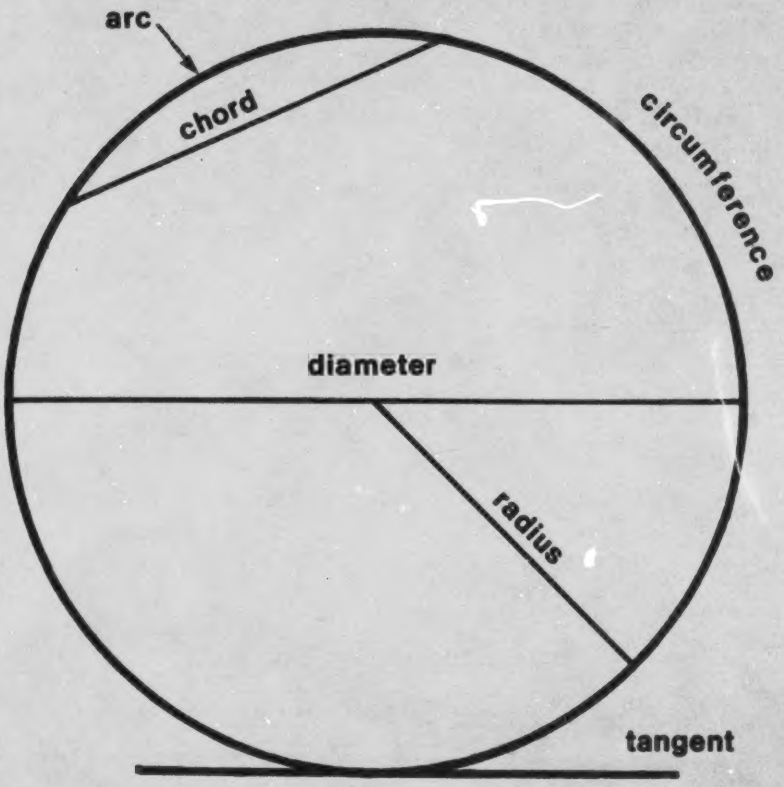


GAS FURNACE

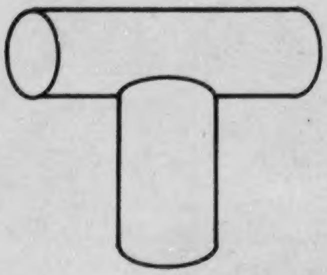
PARTS OF A SPOT WELDER



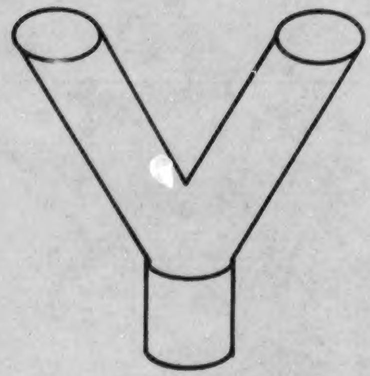
PARTS OF A CIRCLE



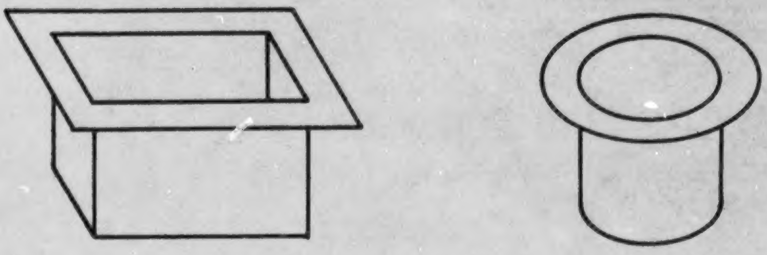
TYPES OF JOINTS



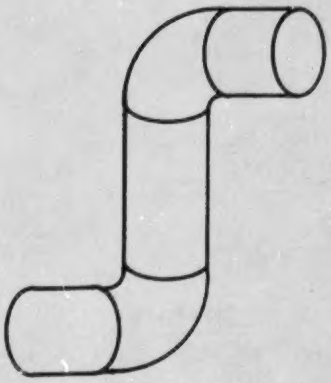
TEE



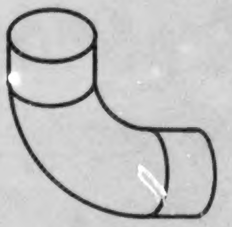
WYE



FLANGES



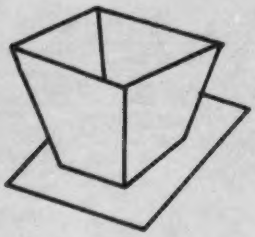
OGEE

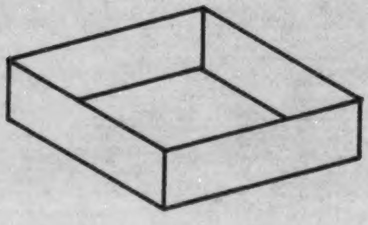


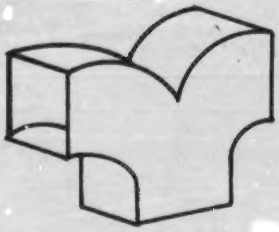
ELBOW

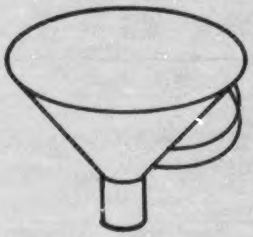
TM-5

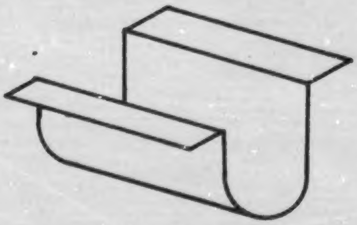
COMMON SHEET METAL SHAPES

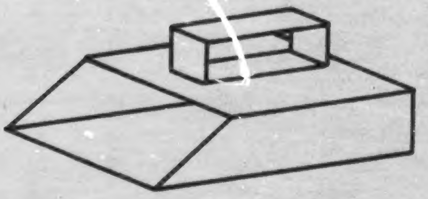


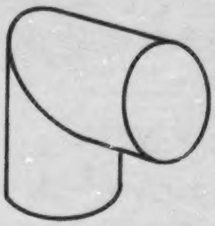


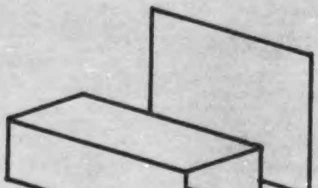












UNIT II

SHEET METAL FABRICATION

ASSIGNMENT SHEET 1--FIGURE CIRCUMFERENCE

Directions: Figure the circumference for each diameter given below.

A. Using the formula 3.14 x Diameter = circumference figure the circumference for each of the pipe sizes listed. Show your work.

1. 5"

2. 10"

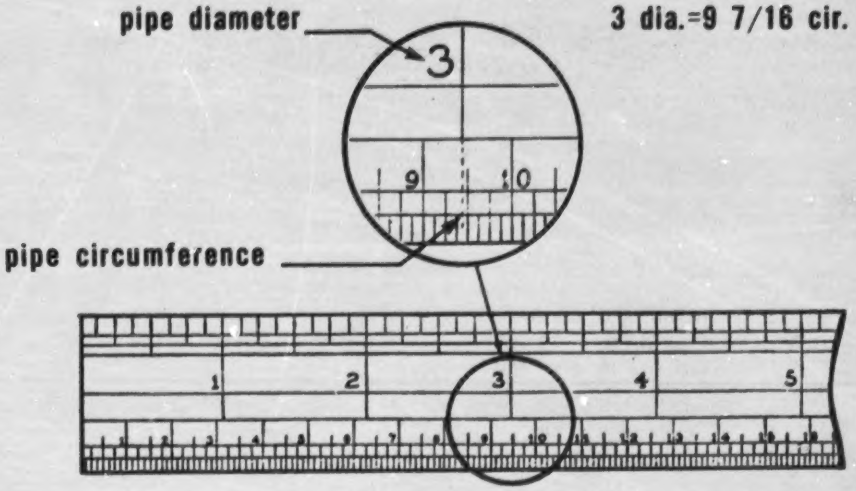
3. 6"

4. 8"

5. 12"

B. Using the circumference rule shown below figure the circumference for each pipe size listed below.

EXAMPLE:



1. 3 1/2"
2. 4"
3. 4 3/4"
4. 5 1/4"
5. 33"

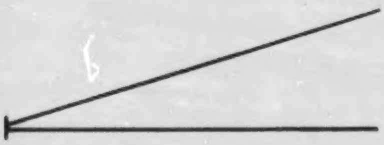
UNIT II

SHEET METAL FABRICATION

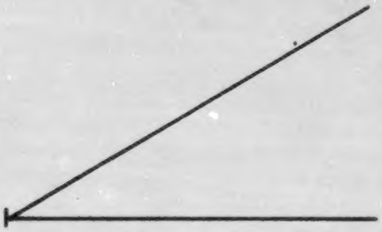
ASSIGNMENT SHEET 2--MEASURE WITH A PROTRACTOR

DIRECTIONS: Use a protractor to measure each of the angles in A. Write your answer in the blank provided. Use your protractor to draw each of the angles shown in B.

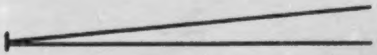
A.



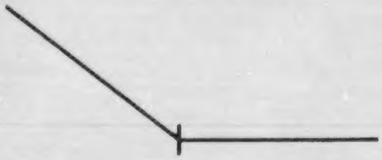
1. _____



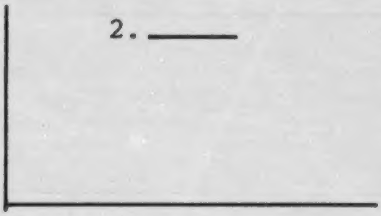
2. _____



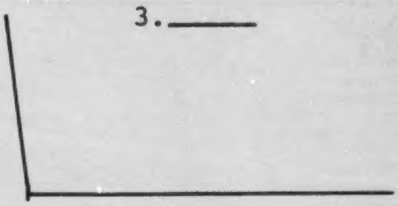
3. _____



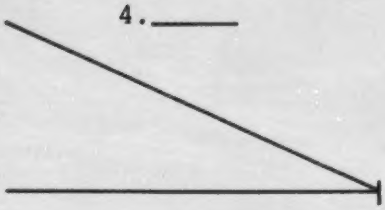
4. _____



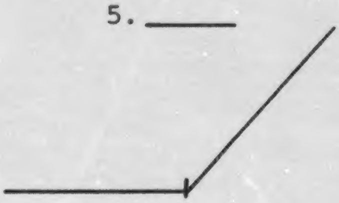
5. _____



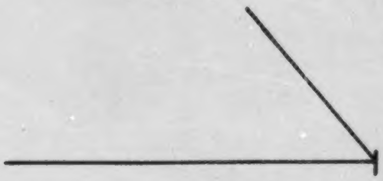
6. _____



7. _____



8. _____



9. _____

B.

1. 45°

2. 35°

3. 120°

4. 90°

5. 20°

6. 65°

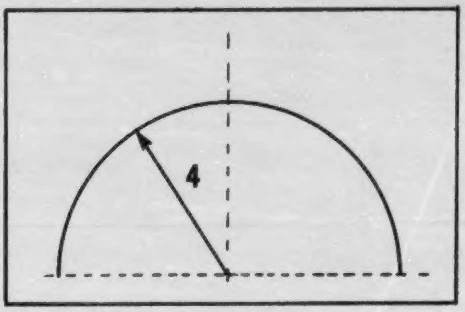
UNIT II

SHEET METAL FABRICATION

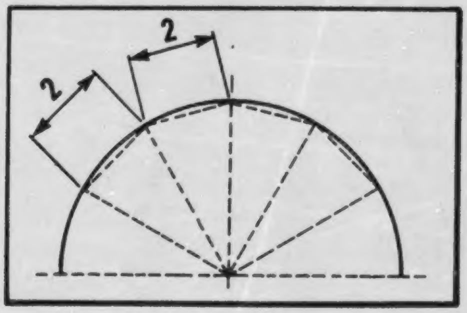
ASSIGNMENT SHEET 3--DEVELOP PYRAMID PATTERN

DIRECTIONS: On a piece of paper layout the pyramid pattern as described below. Then cut out the pattern and assemble it.

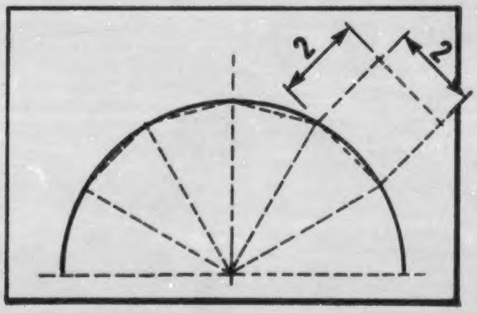
A. Locate a point on the top of the paper so that you can swing a 4-inch arc with a compass.



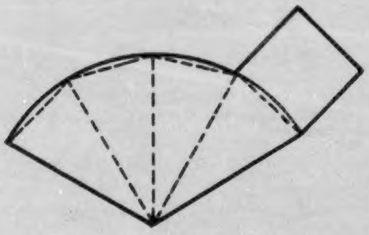
B. Draw four triangles with a 2-inch base and the center point of the arc as the top of each triangle.



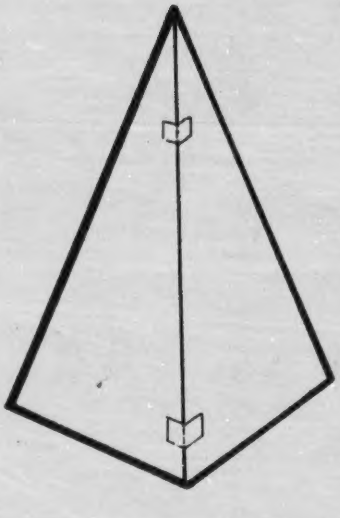
C. Draw a square box on the base of one of the triangles with each side being 2 inches long.



D. Cut out the shape.



E. Fold the shape into a pyramid and tape the joints.



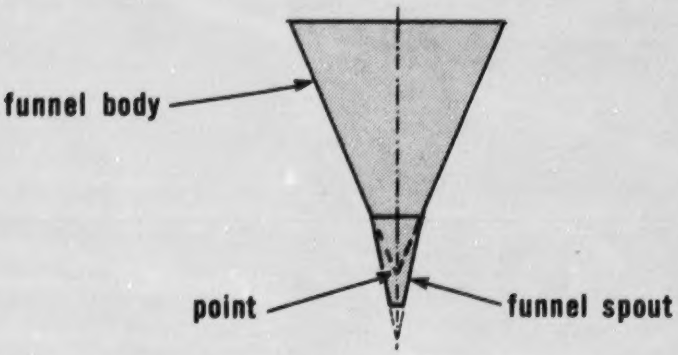
UNIT II

SHEET METAL FABRICATION

ASSIGNMENT SHEET 4--LAY OUT A FLAT PATTERN OF A FUNNEL

Directions: On a sheet of paper, draw a funnel as described below. Then cut out and assemble the pattern.

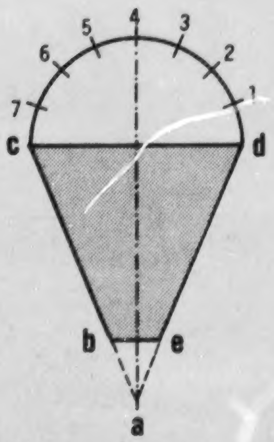
A. Draw a front view of a funnel to the full size, as shown below.



(NOTE: Extend the lines from the sides of the funnel until they come to a point.)

B. Draw a semicircle at the large end of the funnel body.

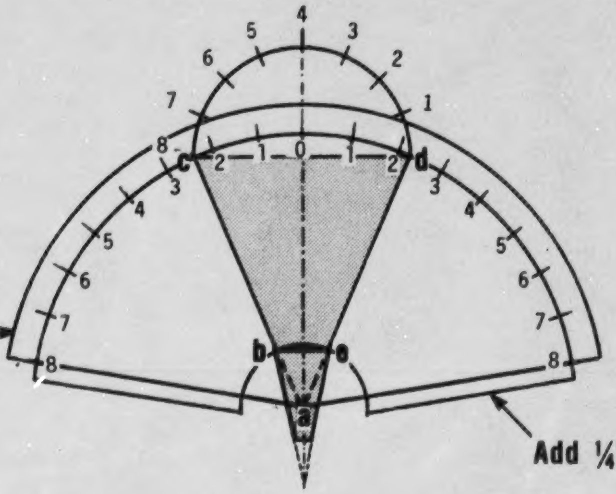
C. Divide this semicircle into eight equal parts.



D. Make a flat layout of the funnel body.

1. Using your compass, draw an arc with the radius being from point a to point c. This will be the outside edge of your pattern.

2. Using the distance from point a to point d, draw another arc.



Extend for wire edge

Add ¼" for for lap seam

3. With your compass, mark off 16 marks on the large arc you have drawn. (You will have 8 marks on either side of o that are the same length as the spaces on the semicircle.)

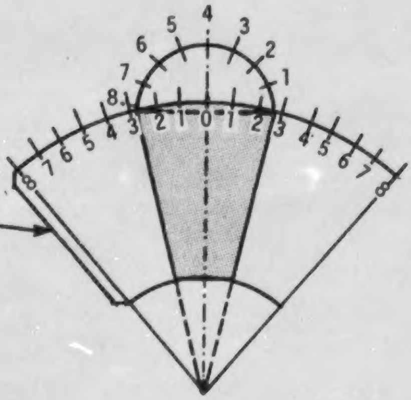
4. Draw line from the center point of this arc to the last mark on each side.

(NOTE: Extend this line 2½ times the diameter of the wire for making a wire edge.)

5. Add ¼ inch on each side for a soldered lap seam.

E. Lay out the spout of the funnel in the same way.

1. Lay out the arcs.



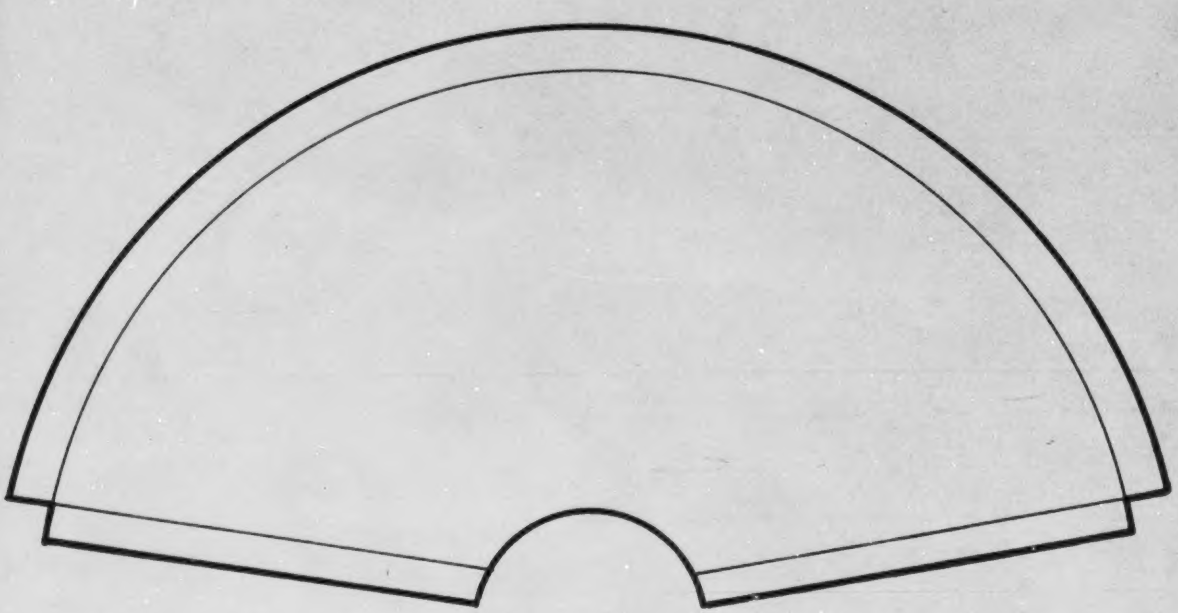
Extend for lap seam

2. Mark off the spaces.

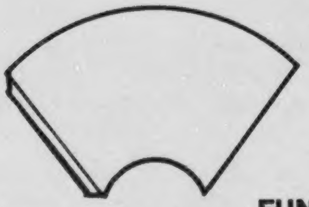
3. Add a ¼-inch extension for a soldered seam.

F. Cut out the two patterns and assemble them.

(NOTE: Use tape to hold the parts together.)



FUNNEL BODY



FUNNEL SPOUT

UNIT II

SHEET METAL FABRICATION

JOB SHEET 1--FORM A PITTSBURG LOCK SEAM

I. Tools and materials

A. 2 pieces of 16 to 30 gauge sheet metal (2" x 6")

B. Sheet metal brake

C. Steel rule

D. Scratch awl

E. File

F. Ballpeen hammer

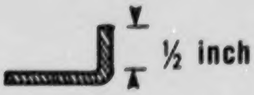
II. Procedures

A. Remove all burrs from the two pieces of metal.

B. Mark one piece of the metal 1/2 inch from one end.

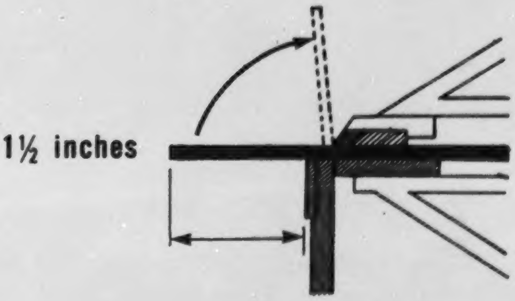
(NOTE: Always mark both sides of the metal.)

C. Bend the metal to 90° with the brake.

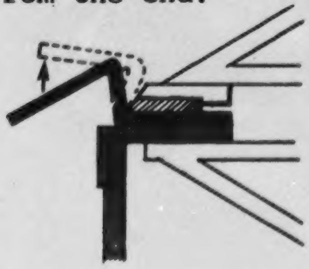


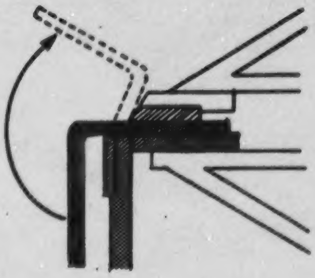
D. Mark the other piece of metal every 1/2 inch for 2 inches from the end.

E. Bend the metal on the marks 1 1/2 inches from the end.

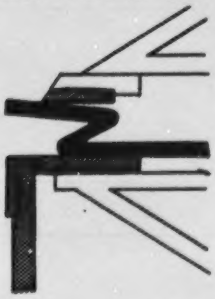


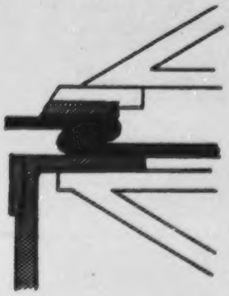
F. Turn the bent piece over on the brake with the long end down and bend the metal as far as possible on the mark 1 inch from the end.



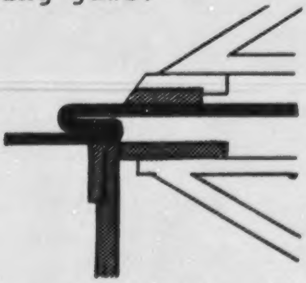


G. Place the bent metal in the brake so the metal may be bent flat.

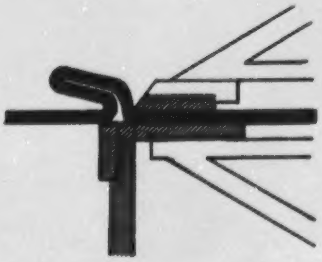




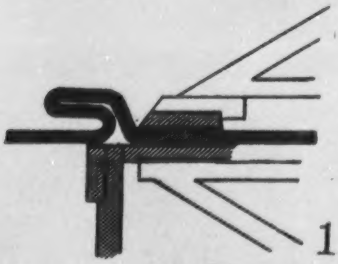
H. Place the long end in the brake so that the bends are just outside the clamping jaws.



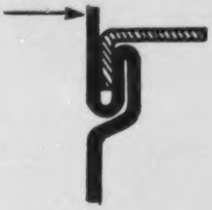
I. Clamp the jaws together so the bend is bent upward.



J. With the ball peen hammer, tap the bend downward.

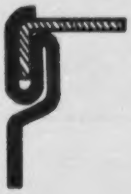


K. Place the bent edge of the first piece of metal into the upper "U" of the second part.



L. Place the pieces on a solid backing.

M. Tap the upper edge of the second part over the corner of the first part until both are tightly locked.



N. Clean up the work area and return tools to their proper storage.

UNIT II

SHEET METAL FABRICATION

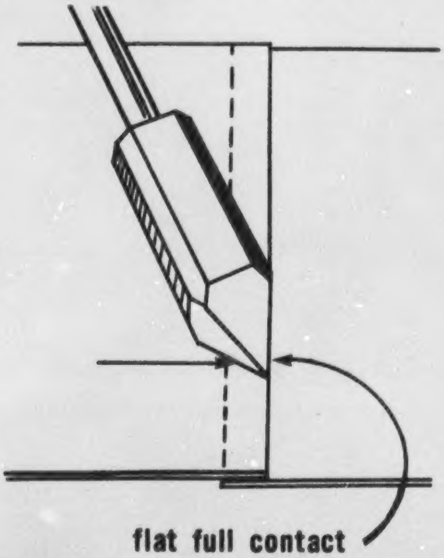
JOB SHEET 2--SOLDER A JOINT

I. Tools and materials

- A. Safety glasses
- B. Solder flux or muratic acid
- C. Bar solder
- D. Soldering iron
- E. Two pieces of sheet metal
- F. Wire brush
- G. Solution of Sal Ammonia

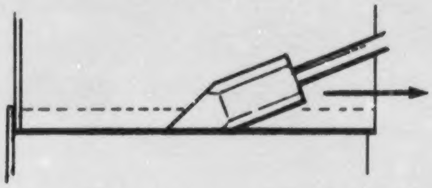
II. Procedures

- A. Put on safety glasses.
- B. Clean the metal with a wire brush.
- C. If flux is not used, clean the metal with muratic acid.
- D. If flux is to be used, apply the flux to the seam.
- E. Make sure the seam is closed as tightly as possible.
- F. Heat the soldering iron in the furnace or with the heating torch.
- G. Place the soldering iron flat against the area to be soldered.



H. Apply the bar solder to the edge of the metal.

I. Move the soldering iron slowly along the seam.



J. Add solder as needed to complete the seam.

K. Clean the iron by dipping it into a solution of Sal Ammonia block and water.

CAUTION: Do not breathe the fumes.

L. Clean up the work area and return tools to their proper storage.

M. Turn in your work to your instructor.

UNIT II

SHEET METAL FABRICATION

JOB SHEET 3--RIVET A JOINT

I. Tools and materials

   A. Two pieces of 16-26 gauge sheet metal

   B. 1/4 electric drill

   C. Rivets

   D. Drill bit (diameter of rivets used)

   E. Center punch

   F. Ball peen hammer

   G. Scratch awl

   H. Ruler

   I. Rivet set

II. Procedures

   A. Clamp the pieces of sheet metal together

   B. Mark off hole locations for rivets

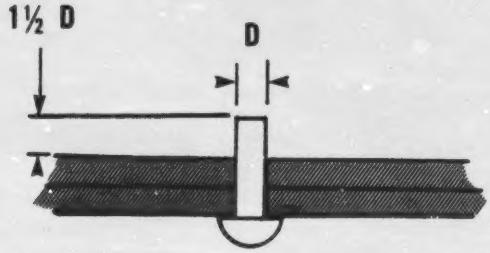
   (NOTE: Rivets should be evenly spaced so they will provide best support for the joint.)

   C. Center punch each hole location

   D. Drill each hole for the rivets

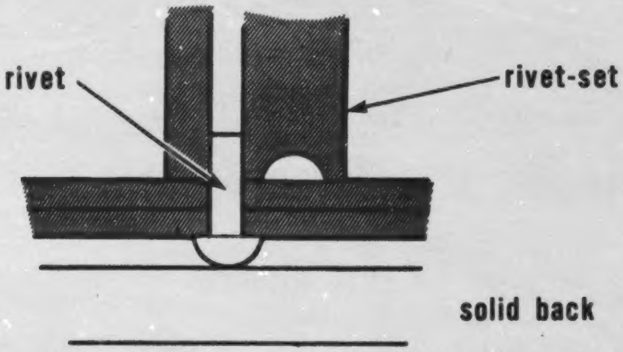
   E. Place the rivet through the hole

   (NOTE: Rivets should extend through the metal about 1 1/2 times the diameter of the rivet.)

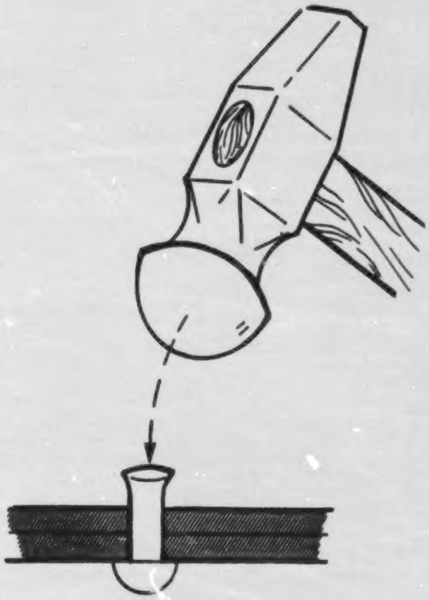


F. Back up the head of the rivet with a solid bar or anvil.

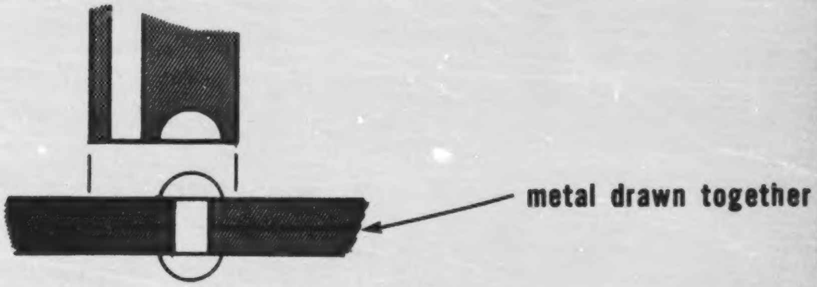
G. Draw the metal and rivet head together with the rivet set.



H. Upset the rivet with the ball end of the ball peen hammer.



I. Shape the rivet head with the cup-shaped part in the rivet set.



J. Place all other rivets in the holes and set them.

K. Clean up the work area and return tools to their proper storage.

L. Turn in your work to your instructor.

UNIT II

SHEET METAL FABRICATION

JOB SHEET 4-- LAY OUT AND ASSEMBLE A BOX

I. Tools and materials

   A. Tin snips

   B. Scratch awl

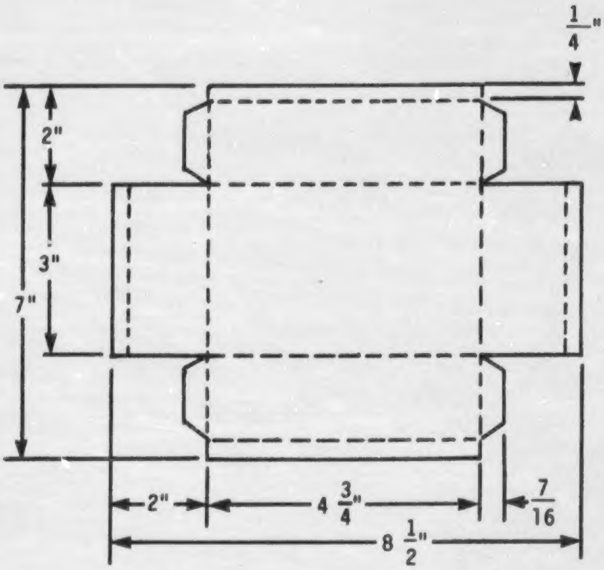
   C. Steel rule

   D. 22-26 gauge sheet metal

   E. Blueprint at right

   F. Ball peen

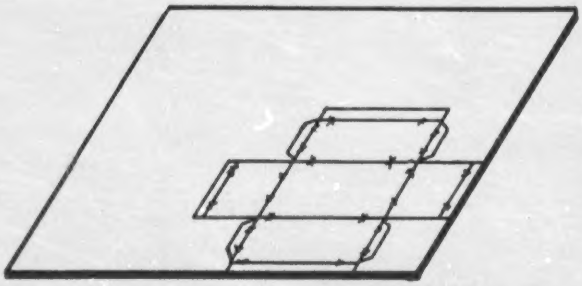
   G. Hand seamers



II. Procedures

   A. Lay out the pattern of the box in one corner of the sheet metal.

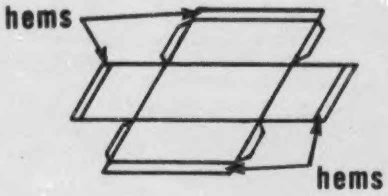
   (NOTE: Notches should be 45°)



B. Cut the pattern out with tin snips.

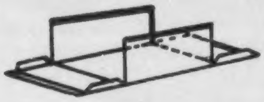
CAUTION: Be careful not to cut your hands on the sharp edges of the metal.

C. Bend each hem to the inside of the box.



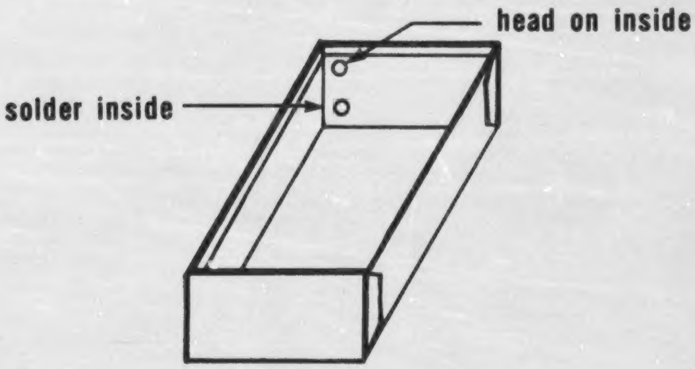
D. Flatten the hems between the jaws of the brake.

E. Bend the two long sides to the inside of the box.



F. Bend the ends of the box inward in the brake or with hand seamers.

(NOTE: If the brake is used, part of the end flanges will be flattened. These may be bent back over the long sides of the box after the ends are bent in place.)



G. Rivet or solder all joints in place.

(NOTE: See Job Sheet 2 for soldering procedures.)

H. Clean up the work area and return tools to their proper storage.

I. Turn in your work to your instructor.

UNIT II

SHEET METAL FABRICATION

TEST PART 1

1. Point out the types of sheet metals used in sheet metal fabrication. Write the number of each term on the right in the correct blank on the left.

    _____a. Used when strength and corrosion resistance is required.

    _____b. Used for guttering and trash cans.

    _____c. Used for food containers and kitchen utensils.

    _____d. A reddish-brown sheet metal.

    _____e. A bluish-black surfaced metal.

    _____f. An alloy of copper and zinc.

    _____g. A silver-gray sheet metal.

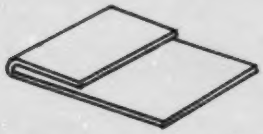
    _____h. Used because of its light weight.

    1. Sheet steel
    2. Cold roll steel
    3. Copper sheet
    4. Galvanized sheet
    5. Tin plate
    6. Aluminum alloy
    7. Stainless steel
    8. Brass sheet

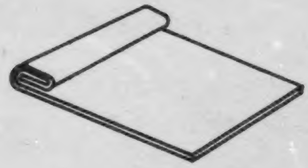
2. Identify the types of seams used in sheet metal assembly by writing the name of each listed below under the correct illustration.

Wire edge
Lap
Riveted corner
Pittsburg corner lock
Single hem

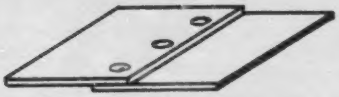
Cap
Pocket
Grooved lock
Standing
Double hem



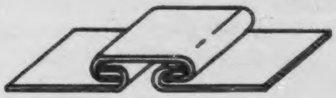
a. ____________________



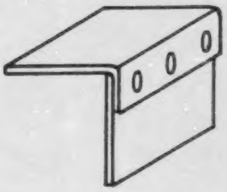
b. ____________________



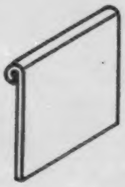
c. ____________________



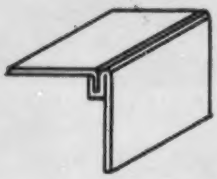
d. ____________________



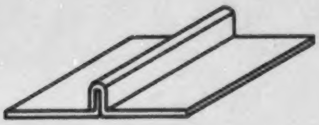
e. ____________________



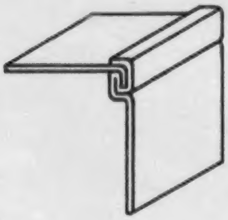
f. ____________________



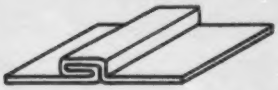
g. ______________________



h. ______________________



i. ______________________



j. ______________________

3. Select the methods of assembling sheet metal by placing a "✓" in front of each correct word listed below.

_____ a. Rivets

_____ b. Glue

_____ c. Solder

_____ d. Sheet metal screws

_____ e. Bar clamps

_____ f. Spot welding

_____ g. Cement

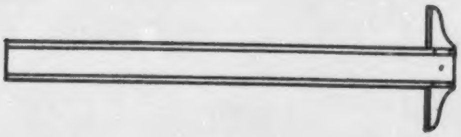
UNIT II

SHEET METAL FABRICATION

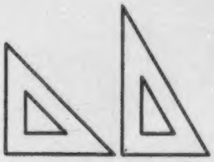
TEST PART 2

1. Identify the types of drafting equipment used in pattern development. Write the name of each listed below in the correct blank under the illustration.

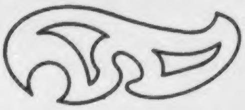
T-square	Scale
Triangles	Protractor
French curve	Drawing instruments



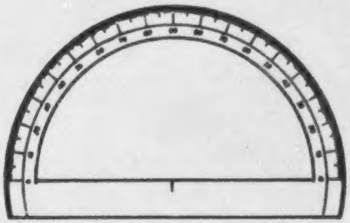
a. ____________________



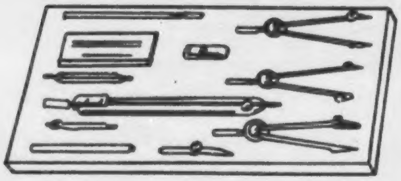
b. ____________________



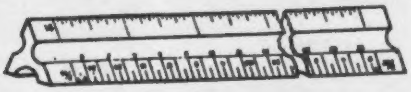
c. ____________________



d. ____________________



e. ____________________



f. ____________________

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2. Draw each of the types of lines used in pattern development that are listed below.

_____a. Straight

_____b. Curved

_____c. Parallel

_____d. Horizontal

_____e. Vertical

_____f. Oblique

_____g. Perpendicular

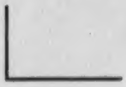
_____h. Center

_____i. Dimension

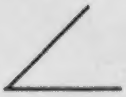
_____j. Extension

3. Identify each of the types of angles used in pattern development by writing the name of each by the correct illustration below.

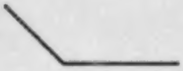
a. ______________________



b. ______________________

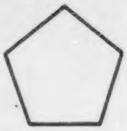


c. ______________________

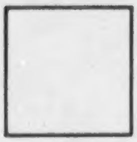


4. Identify each of the plane surfaces used in pattern development by writing each listed below in the correct blank under the illustration.

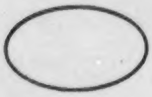
Rectangle
Equilateral triangle
Ellipse
Circle
Right angle triangle
Octagon
Hexagon
Square
Pentagon
Acute angle triangle



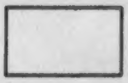
a. ______________________



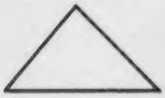
b. ______________________



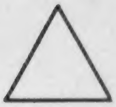
c. ______________________



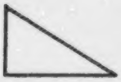
d. ______________________



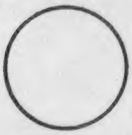
e. ______________________



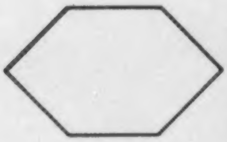
f. ______________________



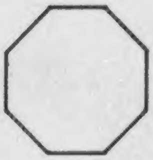
g. ______________________



h. ______________________



i. ______________________

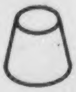


j. ______________________

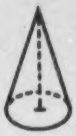
5. Identify the solid geometric figures used in pattern development by writing the name of each in the correct blank below the illustration.

Pyramid
Frustrum

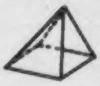
Right cone
Oblique cone



a. ____________________



b. ____________________



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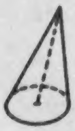


d. ____________________

6. Point out the methods of pattern development by writing the name of each pattern listed below in the correct blank at the left.

Straight-line
Transition

Radial line
Cylindrical

____________________ a. Used for pattern layout of boxes, containers, and trays.

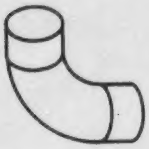
____________________ b. Used for pattern layouts of tubes, pipes, and scoops.

____________________ c. Used for pattern layout of cone-shaped objects.

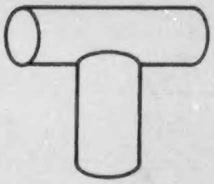
____________________ d. Used for pattern layout of pipe-shaped parts with one square and one round end.

7. Identify each of the types of joints used in sheet metal assembly by writing the name of each listed below in the correct blank under the illustration.

Ogee	Elbow
Wye	Tee
Flange	



a. ____________________



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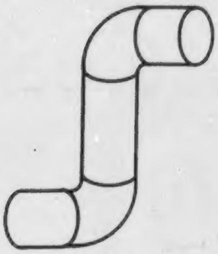

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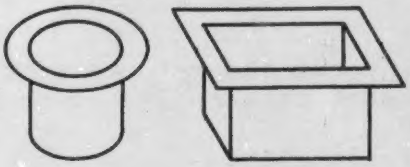
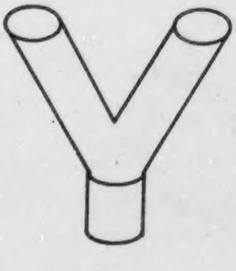


d. ____________________



e. ____________________

UNIT II

SHEET METAL FABRICATION

ANSWERS TO TESTS

Part 1

1. a. 7
   b. 4
   c. 5
   d. 3
   e. 1
   f. 8
   g. 2
   h. 6

2. a. Single hem
   b. Double hem
   c. Lap
   d. Cap
   e. Riveted corner
   f. Wire edge
   g. Pocket
   h. Standing
   i. Pittsburg corner lock
   j. Grooved lock

3. a.
   c.
   d.
   f.

Part 2

1. a. T-square
   b. Triangles
   c. French curve
   d. Protractor
   e. Drawing instruments
   f. Scale

2. Evaluated to the satisfaction of the instructor.

3. a. Right angle
   b. Acute angle
   c. Obtuse angle

4. a. Pentagon

b. Square

c. Elipse

d. Rectangle

e. Acute angle

f. Equilateral triangle

g. Right angle

h. Circle

i. Hexagon

j. Octagon

5. a. Frustrum

b. Right cone

c. Pyramid

d. Oblique cone

6. a. Straight-line

b. Cylindrical

c. Radial

d. Transition

7. a. Elbow

b. Tee

c. Ogee

d. Flange

e. Wye

Section C

ORNAMENTAL IRONWORK

ORNAMENTAL IRONWORK

UNIT OBJECTIVE

After completing this unit, the student will be able to use the proper terms and safety procedures when operating equipment used in ornamental ironwork. The student will also be able to produce the various shapes and finishes on the different parts and select the appropriate method for assembling the parts. This knowledge will be evidenced through demonstration and by satisfactorily completing a unit test.

After completion of this unit, the student will be able to:

1. Match terms associated with ornamental ironwork to the correct definition.
2. Identify the correct safety rules to follow when using equipment for ornamental ironwork.
3. Identify the equipment used in ornamental ironwork.
4. Point out the uses of wrought ironwork.
5. Identify each of the shapes used in wrought ironwork.
6. Identify the types of ironwork finishes.
7. Select the correct methods of assembling ironwork.
8. Demonstrate the ability to:
    a. Form a scroll
    b. Form a twist

ORNAMENTAL IRONWORK

SUGGESTED TEACHING ACTIVITIES

I. Objectiva sheet

   A. Discuss the unit objective with the students

   B. Discuss each specific objective with the students

   C. Have the students complete the objectives in the most logical sequence for shop organization.

   D. Add any objectives necessary.

II. Information sheet

   A. Discuss the various use of wrought iron work.

   B. Discuss the types of projects the students may build with wrought iron.

   C. Explain the use of the wrought iron equipment in the shop.

III. Transparency masters

   (NOTE: Transparencies are included in the student manuals as information sheets.)

   A. TM-1--A ROD PARTER

   B. TM-2--TYPES OF UNIVERSAL BENDERS

   C. TM-3--METHODS OF FORMING METAL

IV. Job sheets

   A. JOB SHEET 1--FORM A SCROLL

      1. Assist the students in designing a scroll pattern on paper.

      2. Demonstrate the procedure for forming a scroll.

   B. JOB SHEET 2--FORM A TWIST

      1. Decide the length required for the twist.

      2. Demonstrate the procedure for forming a twist.

V. Unit test

A. The unit test is a one part test covering the information sheet.

B. Various approaches may be used in testing:

1. Have students identify safety aspects of wrought iron equipment.

2. Use the test as an assignment.

3. Give an oral test over the information.

C. Include test parts corresponding to any information area added to the unit.

VI. Answers to test

A. Answers are based on total information covered in the unit.

B. For convenience of grading, make corresponding answer sheets for additional test parts added.

VII. References

A. A Suggested Basic Course Outline for General Metal Trades Cluster. Occupational Curriculum Laboratory, East Texas State University, Commerce, Texas 75428

B. Walker, John. Exploring Metalworking. Basic Fundamentals. Goodheart-Wilcox, 123 W. Taft Drive, South Holland, Illinois 60473. Edition, 1972.

C. Walker, John. Modern Metalworking. Goodheart-Wilcox, Inc. 123 W. Taft Drive, South Holland, Illinois 70473.

ORNAMENTAL IRONWORK

INFORMATION SHEET

I. Terms and definitions

   A. Wrought ironwork (ornamental)--Metal shaped into a decorative or functional part by heating, bending, and shaping.

   B. Drawn--Metal which is heated and then hammered into the desired shape.

   C. Jig--Any special shaped metal or device used in bending metal to various shapes.

   D. Peening--Shaping metal with a hammer.

II. Safety

   A. Wear safety glasses at all times to protect your eyes from rust and dirt that may "pop off" the metal.

   B. Make sure all bending machines are securely fastened to the bench or floor.

   C. Do not use bending machines without first receiving directions on the use of the machine.

   D. Keep fingers clear of bender parts.

   E. Handle long sections of metal carefully so someone nearby will not be hit.

   F. Get help when moving heavy or long sections of metal around others or equipment.

   G. Become familiar with safety and operating procedures for welding equipment before you use it.

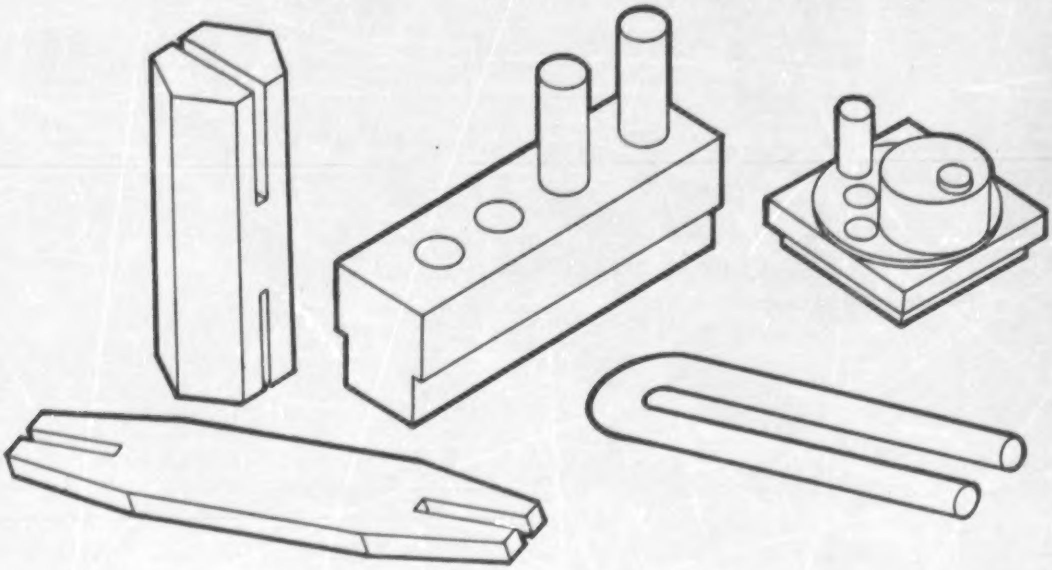
   H. Keep finishing materials vented and away from open flame.

III. Equipment

A. Rod parter--Used in place of a hacksaw to cut metal rods.

B. Bending jigs--Used in a vise to make simple bends in lighter metal.

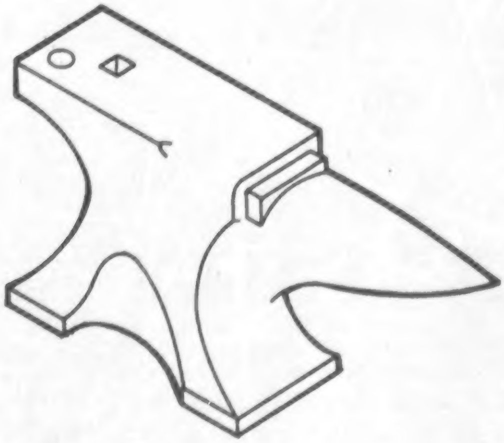
(NOTE: Bending jigs come in a variety of shapes and sizes.)



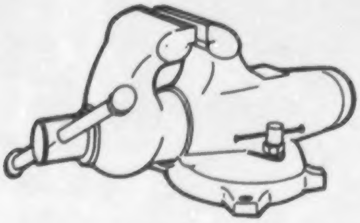
C. Universal bender--Used to bend angle iron, bar stock, rods, and pipe.

(NOTE: Two commonly used benders are Di-Acro and Hossfield. See TM-2)

D. Anvil--Used for drawing or shaping metal.



E. Vise--Used to hold jigs or metal during bending operations.



IV. Uses for wrought ironwork

A. Decoration

EXAMPLES: Hinges, doorlatches, trim for railings

B. Furniture

EXAMPLES: Lawn and patio furniture, end and coffee tables, plant stands

C. Railings

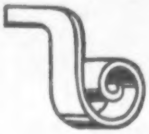
EXAMPLES: Balcony railings, step railings, equipment guardrailings

D. Supports

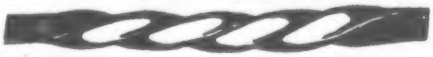
EXAMPLES: Porch, beam, or stairwell supports

V. Ironwork shapes

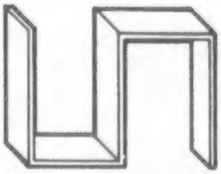
A. Circles, scrolls, and curves



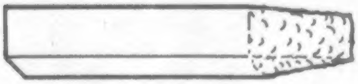
B. Twists or spirals



C. Angles



D. Drawn



VI. Types of ironwork finishes

A. Peened--Rough surface formed by numerous blows of the round end of a ball-peen hammer.

B. Black lacquer--A flat black finish.

C. Paint--Any color of finish that can be produced.

D. Spot finished--A solid pattern of circular marks.

VII. Methods of assembling ironwork

A. Bolts

B. Arc welding

C. Spot welding

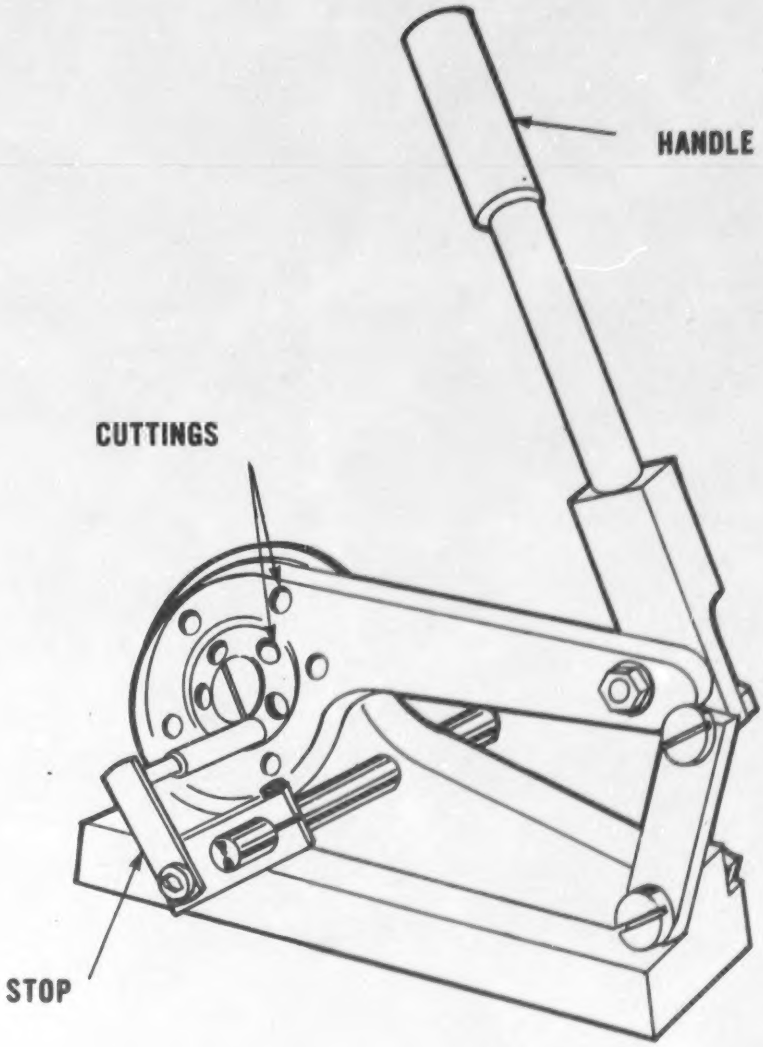
D. Solder

E. Rivets

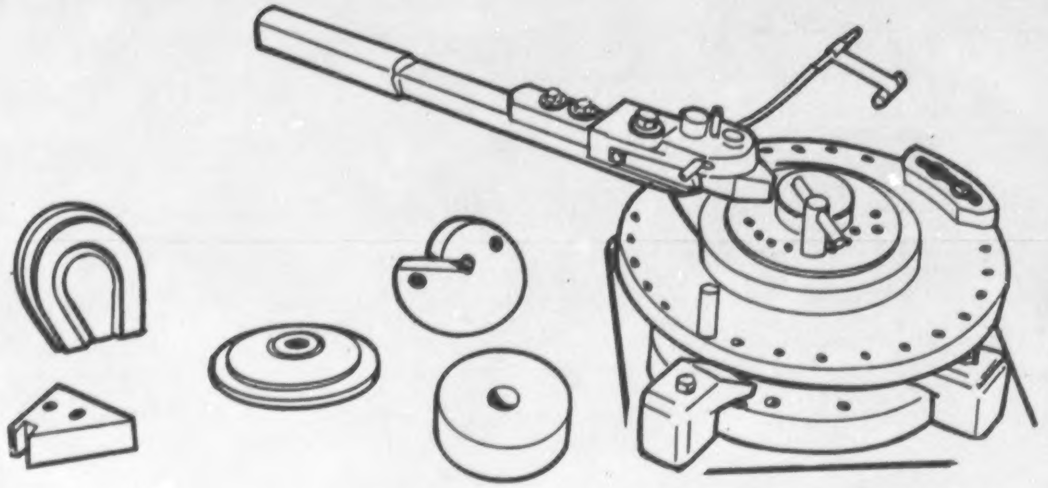
F. Forging

G. Oxyacetylene welding

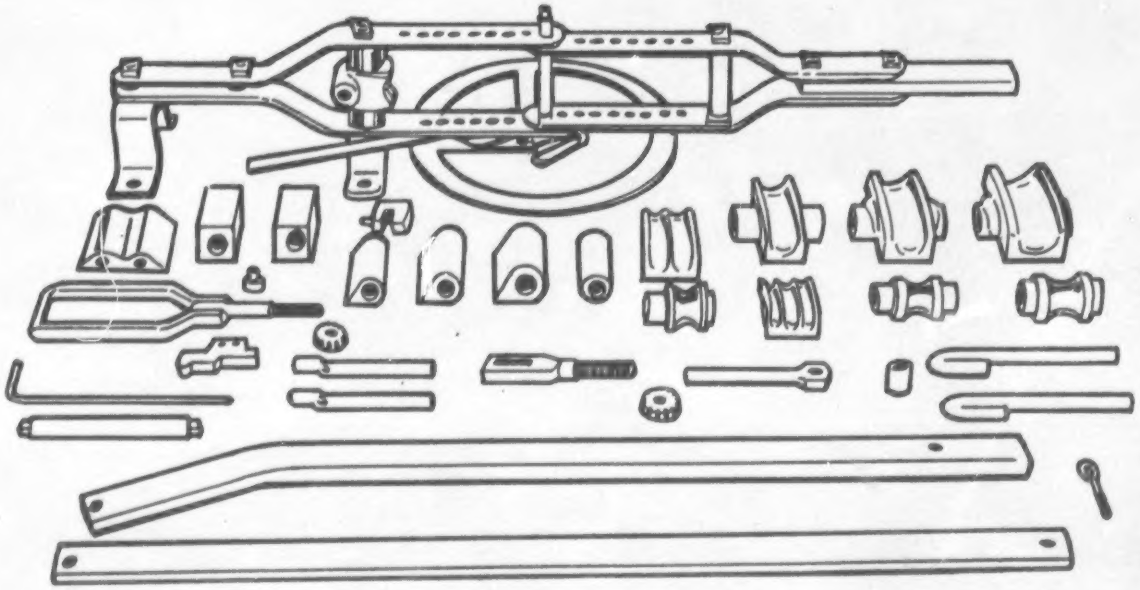
A ROD PARTER



TYPES OF UNIVERSAL BENDERS

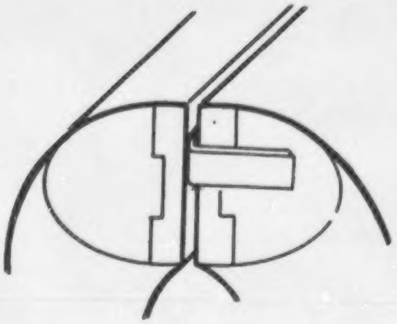


DI-ACRO

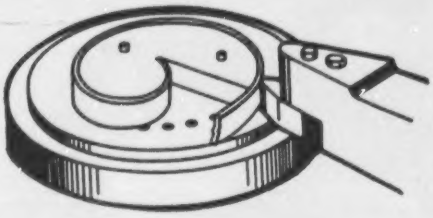


HOSSFIELD

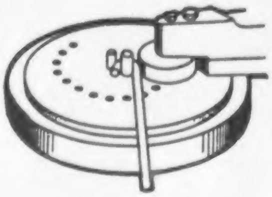
METHODS OF FORMING METAL



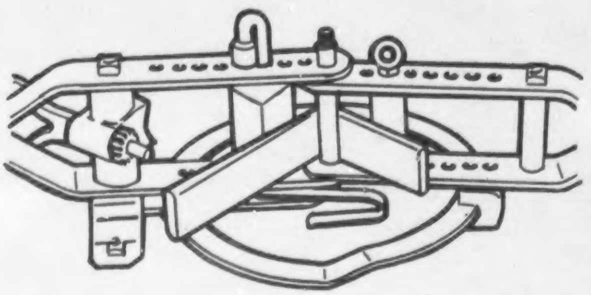
SQUARE BENDS IN A VISE



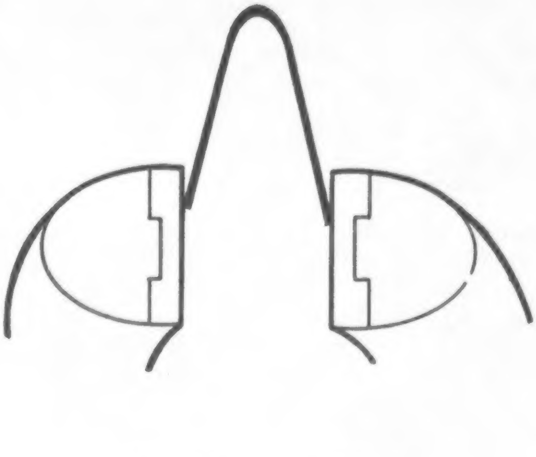
SCROLLS IN A BENDER



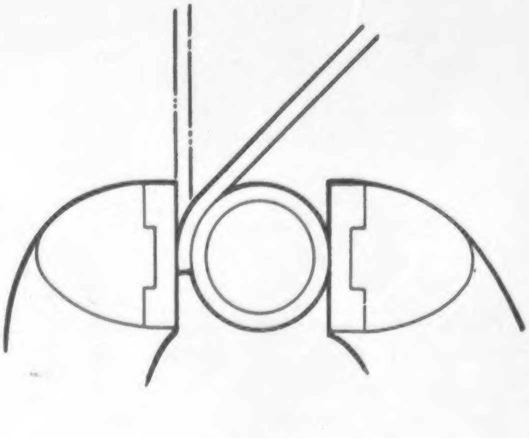
EYE SHAPING IN A BENDER



ANGLES IN A BENDER



ANGLES IN A VISE



CURVES IN A VISE

ORNAMENTAL IRONWORK

JOB SHEET 1--FORM A SCROLL

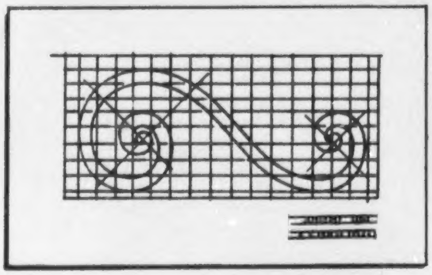
I. Tools and materials

- A. 1/8" x 1" flat bar stock
- B. Bending jig
- C. Vise
- D. Tape measure
- E. Hacksaw
- F. File

II. Procedures

A. Layout the full size pattern of the scroll on a sheet of paper.

(NOTE: Any shape may be used.)

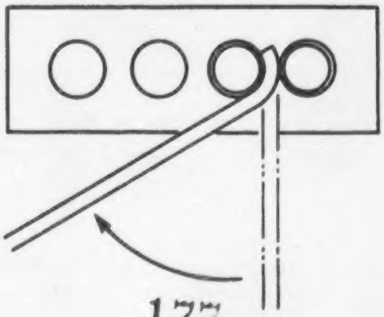


B. Measure the length of the material required for the scroll on the paper.

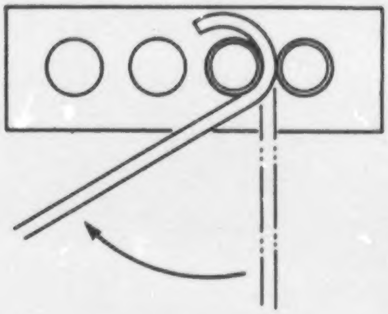
C. Measure the bar stock and cut to length.

D. Place the bending jib in the vise and tighten securely.

E. Place the tip of the metal in the bending jig and begin the curve.



F. Move the bar stock into the jig and continue the bend.



G. Continue moving the material into the jig and forming the bend.

H. Check the material against the paper pattern and make changes as needed.

I. If a scroll is required on both ends, reverse the material in the bending jig and repeat the bending process.

J. Remove any burrs with a file.

K. Clean up the work area and turn in the work to your instructor.

ORNAMENTAL IRONWORK

JOB SHEET 2--FORM A TWIST

I. Tools and materials

A. 1/8" x 3/4" flat bar stock

B. Vise

C. Open-end adjustable wrench

D. Tape measure

E. Hacksaw

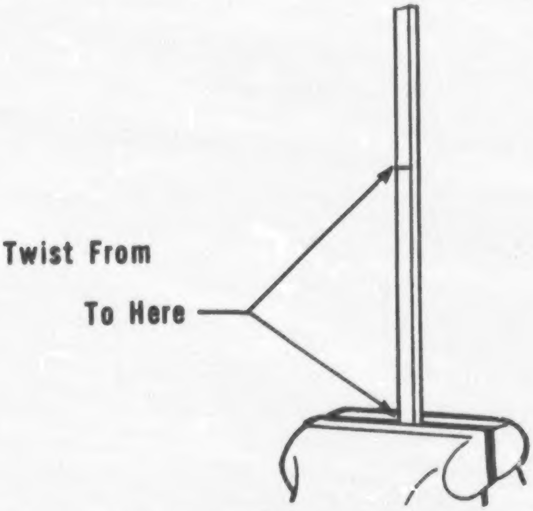
F. File

II. Procedures

A. Measure and cut the stock to the desired length.

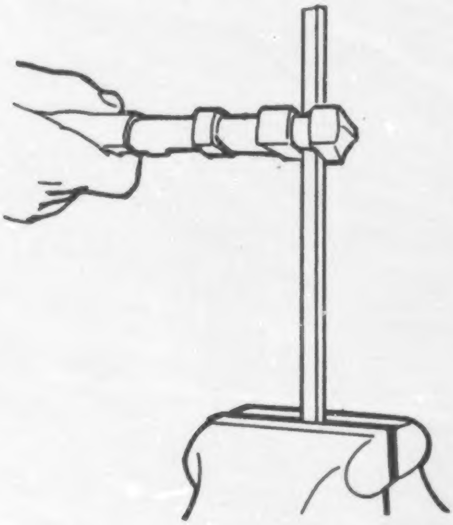
(NOTE: Remember the metal will shorten as it is twisted.)

B. Mark the area where the twist should be located.



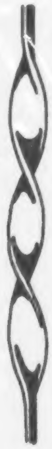
C. Place the material in the vise with the lower mark just above the edge of the vise.

D. Place the adjustable wrench securely on the upper mark.



E. Turn the wrench until the desired twist is reached.

CAUTION: Do not twist the metal so much that the metal breaks.



F. Remove any burrs with a file.

G. Clean up the work area and turn in the work to your instructor.

ORNAMENTAL IRONWORK

TEST

1. Match terms associated with ornamental ironwork to the correct definition by placing the number of each term on the right in the correct blank on the left.

_____ a. Any special shaped metal or device used in bending

_____ b. Shaping metal with a hammer

_____ c. Metal shaped into a decorative or functional part by heating, bending or shaping

_____ d. Metal which is heated and then hammered into a desired shape.

1. Drawing out
2. Jig
3. Wrought ironwork
4. Peening

2. Identify the correct safety rules to follow when using equipment for ornamental ironwork by placing a "✓" in front of each below.

_____ a. Wear safety glasses at all times to protect your eyes from rust and dirt that may "pop off" the metal.

_____ b. Make sure bending machines are securely fastened to the floor.

_____ c. Use bending machines when you think you can operate it.

_____ d. Keep fingers clear of bender parts.

_____ e. Handle long sections of metal carefully so someone nearby will not be hit.

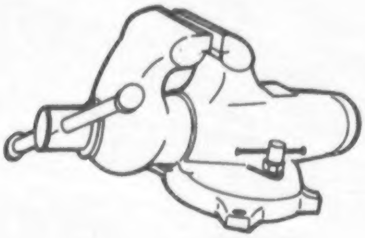
_____ f. Try to move heavy metal by yourself so no one will be bothered.

_____ g. Become familiar with safety and operating procedures for welding equipment before you use it.

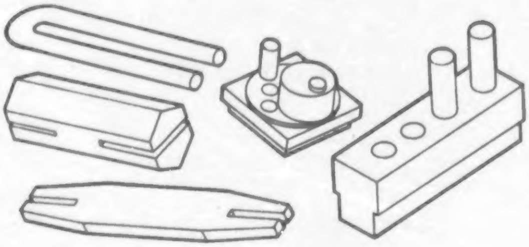
_____ h. Keep finishing materials vented and away from open flame.

3. Identify the equipment used in ornamental ironwork by writing the name of each listed below in the correct blank.

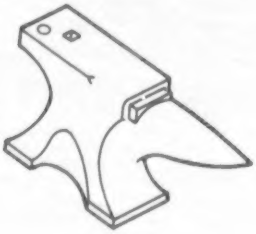
Anvil
Bending jigs
Vise
Universal bender
Rod parter



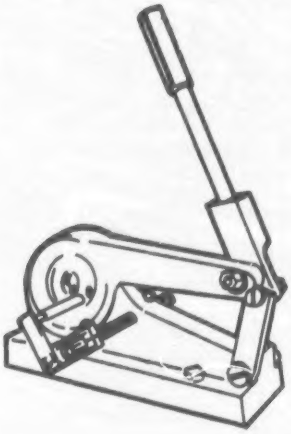
a. ______________________



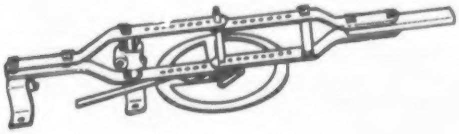
b. ______________________



c. ______________________



d. ______________________



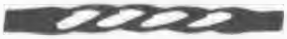
e. ______________________

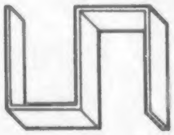
4. Point out each of the uses of wrought ironwork by placing a "√" in front of the correct answers below.

____a. Decoration
____b. Supports or porches or stairs
____c. Lawn furniture
____d. Machine parts
____e. Railings around equipment or on balconies
____f. Precision measuring tools

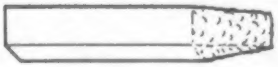
5. Identify each of the shaped used in wrought ironwork by writing each name from the list below in the correct blank.

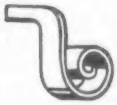
Scroll
Angle
Twist
Drawn





a. ____________________ b. ____________________





c. ____________________ d. ____________________

6. Identify the types of ironwork finishes by writing the name of each listed below beside the correct description.

Peened
Black lacquer
Spot finish
Paint

____________________ a. A solid pattern of circular marks.

____________________ b. Rough surface formed by blows of the round end of a ball peen hammer.

____________________ c. Any color finish that can be produced.

____________________ d. A flat black finish.

7. Select the correct methods of assembling ironwork by circling the words below that apply.

a. Bolts
b. Arc welding
c. Forging
d. Gluing

e. Rivets
f. Solder
g. Spot welding
h. Oxyacetylene welding
i. Wooden dowels

ORNAMENTAL IRONWORK

ANSWERS TO TEST

1. a. 2
   b. 4
   c. 3
   d. 1

2. a. ✓
   b. ✓
   c.
   d. ✓
   e. ✓
   f.
   g. ✓
   h. ✓

3. a. Vise
   b. Bending jigs
   c. Anvil
   d. Rod parter
   e. Universal bender

4. a. ✓
   b. ✓
   c. ✓
   d.
   e. ✓
   f.

5. a. Twist
   b. Angle
   c. Drawn
   d. Scroll

6. a. Spot finish
   b. Peened
   c. Paint
   d. Black lacquer

7. a. ✓
   b. ✓
   c. ✓
   d.
   e. ✓
   f. ✓
   g. ✓
   h. ✓
   i.